ERDC TR-13-9

Engineer Research and Development Center

US Army Corps of Engineers®
Engineer Research and Development Center

ERDC
INNOVATIVE SOLUTIONS for a safer, better world

Environmental Science and Technology Certification Program

Demonstration of Incremental Sampling Methodology for Soil Containing Metallic Residues

Project ER-0918

Jay L. Clausen, Thomas Georgian, Anthony Bednar, Nancy Perron, Andrew Bray, Patricia Tuminello, Gordon Gooch, Nathan Mulherin, Arthur Gelvin, Marc Beede, Stephanie Saari, William Jones, and Shawna Tazik

September 2013

The US Army Engineer Research and Development Center (ERDC) solves the nation's toughest engineering and environmental challenges. ERDC develops innovative solutions in civil and military engineering, geospatial sciences, water resources, and environmental sciences for the Army, the Department of Defense, civilian agencies, and our nation's public good. Find out more at www.erdc.usace.army.mil.

To search for other technical reports published by ERDC, visit the ERDC online library at http://acwc.sdp.sirsi.net/client/default.

Demonstration of Incremental Sampling Methodology for Soil Containing Metallic Residues

Project ER-0918

Jay L. Clausen, Nancy Perron, Gordon Gooch, Nathan Mulherin, Arthur Gelvin, Marc Beede, and Stephanie Saari

Cold Regions Research and Engineering Laboratory (CRREL)
US Army Engineer Research and Development Center
72 Lyme Road
Hanover, NH 03755-1290

Thomas Georgian

Environmental and Munitions Center of Expertise (EM CX)
US Army Corps of Engineers
1616 Capitol Avenue
Omaha, NE 68102

Anthony Bednar, Andrew Bray, Patricia Tuminello, William Jones, and Shawna Tazik

Environmental Laboratory (EL)
US Army Engineer Research and Development Center
Waterways Experiment Station
3909 Halls Ferry Road
Vicksburg, MS 39180-6199

Final Report

Prepared for Environmental Security Technology Certification Program (ESTCP)
Arlington, VA 22203

Under Project ER-0918

Abstract

Objectives of this project were to demonstrate improved data quality for metal constituents in surface soils on military training ranges and to develop a methodology that would result in the same or lower cost. The demonstration was conducted at two inactive small-arms ranges at Fort Eustis, VA, and Kimama Training Site (TS), ID, and at one active small-arms range at Fort Wainwright, AK. The samples included 63 Incremental Sampling Methodology (ISM) and 50 conventional grab from Fort Wainwright, 18 ISM and 30 grab from Kimama TS, and 27 ISM and 33 grab from Fort Eustis. The variability in metal concentrations as measured with replicate samples and evaluated using percent relative standard deviation (RSD) were less than 10% for all metals using ISM. In contrasts, RSDs were often greater than 50% for conventional replicate grab samples. Calculated mean ISM metal concentrations were statistically greater than the mean for conventional grab samples.

Contents

Illustrations

Figures

Tables

Preface

Funding for this demonstration was provided by the Environmental Security Technology Certification Program (ESTCP) under Project ER-0918: *Demonstration of the Attributes of Multi-Increment Sampling and Proper Sample Processing Protocols for the Characterization of Metals on DoD Facilities* with Dr. Andrea Leeson as Program Manager for Environmental Restoration.

This report was prepared by Jay Clausen (Biogeochemical Sciences Branch, Terry Sobecki, Chief) at the US Army Corps of Engineers (USACE) Engineer Research and Development Center (ERDC), Cold Regions Research and Engineering Laboratory (CRREL) in Hanover, New Hampshire (ERDC-CRREL); Anthony Bednar at the ERDC Environmental Laboratory (EL); and Thomas Georgian USACE, Environmental and Munitions Center of Expertise (EM CX). Other team members include Nancy Perron, Gordon Gooch, Nathan Mulherin, Arthur Gelvin, Stephanie Saari, and Marc Beede with ERDC-CRREL; Andrew Bray, Patricia Tuminello, William Jones, and Shawna Tazik with ERDC-EL; Larry Penfold with Test America; and Diane Anderson with APPL Laboratories.

COL Jeffrey R. Eckstein was the Commander of ERDC, and Dr. Jeffery P. Holland was the Director.

Special thanks go to Dr. Andrea Leeson, Dr. Jeffrey Marquesee, and all the ESTCP panel members and technical advisors for the advice and technical review that they have provided.

Thanks also go to Bonnie Packer, Robert Halla, and Anne Woods (all with the National Guard Bureau) for arranging for access to the Kimama Training Site and to Travis McCuin at the USACE Baltimore District for arranging access to Fort Eustis. Additionally, we appreciate the site access coordination provided by Arba Williamson and Amber Michel (Fort Eustis) and COL Kyle Carpenter and MAJ Andrew White (Idaho National Guard for the Kimama Training Site).

This report is dedicated to Alan Hewitt, our colleague who conceived of this project. He is admired for his enthusiasm and energy for scientific research, and his contributions will endure.

Nomenclature

Ag	Silver
Al	Aluminum
ASTM	American Society for Testing and Materials
B	Boron
Ba	Barium
Be	Beryllium
BLM	Bureau of Land Management
BRAC	Base Realignment and Closure
Ca	Calcium
CCB	Continuing Calibration Blank
CCV	Continuing Calibration Verification
Cd	Cadmium
Ce	Cerium
CDF	Cumulative Distribution Function
CEC	Cation Exchange Capacity
CI	Confidence Interval
CMIST	CRREL Multi-Increment Sampling Tool
Cr	Chromium
CRREL	Cold Regions Research and Engineering Laboratory
CSM	Conceptual Site Model
Cu	Copper

DoD	United States Department of Defense
DU	Decision Unit
EL	Environmental Laboratory
EOD	Explosive Ordnance Disposal
ERA	Environmental Research Associates
ERDC	Engineer Research Development Center
ESTCP	Environmental Science Technology Certification Program
Fe	Iron
FP	Firing Point
FUDS	Formerly Used Defense Sites
GPS	Global Positioning System
H_3PO_4	Phosphoric Acid
HCl	Hydrochloric Acid
HPLC	High Performance Liquid Chromatography
ICB	Initial Calibration Blank
ICP-MS	Inductively Coupled Plasma–Mass Spectrometry
ICP-OES	Inductively Coupled Plasma–Optical Emission Spectrometry
ICS	Inter Element Check Standards
ICV	Initial Calibration Verification
IQR	Interquartile Range
IS	Incremental Samples
ISM	Incremental Sample Methodology
ITRC	Interstate Technology Regulatory Council
K	Potassium

LCS	Laboratory Control Sample
MB	Method Blank
MD	Matrix Duplicate
MDL	Method Detection Limit
Mg	Magnesium
MMRP	Military Munitions Response Program
Mn	Manganese
MS	Matrix Spike
MSA	Method of Standard Additions
MSD	Matrix Spike Duplicate
Na	Sodium
NG	Nitroglycerine
Ni	Nickel
ORAP	Operational Range Assessment
P	Phosphorus
Pb	Lead
PSD	Post Serial Dilution
QA/QC	Quality Assurance/Quality Control
QSM	Quality Systems Management
RI/FS	Remedial Investigation/Feasibility Study
RPD	Relative Percent Difference
RSD	[Percent] Relative Standard Deviation
Sb	Antimony
SD	Serial Dilution

SI	Site Investigation
SMF	Sporadic Marginal Failure
Sn	Tin
Sr	Strontium
SRM	Standard Reference Material
SU	Sampling Unit
TAL	Target Analyte List
Th	Thorium
Ti	Titanium
Tl	Thallium
TOC	Total Organic Carbon
TS	Training Site
UCL	Upper Confidence Limit
USACE	United States Army Corps of Engineers
USEPA	United States Environmental Protection Agency
UXO	Unexploded Ordnance
V	Vanadium
W	Tungsten
Zn	Zinc
Zr	Zirconium

Unit Conversion Factors

Multiply	By	To Obtain
acres	4,046.873	square meters
inches	0.0254	meters
miles (US statute)	1,609.347	meters

Executive Summary

Research over the last decade has revealed that releases of energetic constituents into the environment as a result of military training occur in extremely heterogeneous patterns. Conventional soil sampling and sample preparation methodologies are inadequate to address the level of contaminant heterogeneity observed. Recently, there have been questions regarding whether the issues observed for the deposition of energetic constituents also substantively apply to other constituents, such as metals, semivolatile organic compounds, and polychlorinated biphenyls. Our earlier research indicates that metal constituents introduced into the environment as metal residues from small arms and pyrotechnic military training are heterogeneously distributed. As a result of these findings, regulatory agencies are increasingly requiring the United States Department of Defense (DoD) to apply procedures developed for energetics under United States Environmental Protection Agency (USEPA) Method 8330B to the sampling and sample processing of soil samples from small-arms ranges containing metals.

This report was completed as a partial fulfillment of the obligations for Environmental Science Technology Certification Program (ESTCP) Demonstration Project ER-0918. The objectives of this project were to demonstrate improved sampling data quality for metal constituents in surface soils on military training ranges and to develop a methodology that would result in the same or lower cost. We conducted the demonstration at two inactive small-arms ranges. At Fort Eustis, VA, we performed the demonstration at the 1000-in. Rifle Range, which is a Military Munitions Response Program (MMRP) site. The northern range in Training Area 3 of the Kimama Training Site (TS), ID, was the other MMRP demonstration site. We also conducted a demonstration at one active small-arms range at the Range 16 Record Range located within the Small Arms Complex at Fort Wainwright, AK.

For this demonstration, we collected 63 Incremental Sample Methodology (ISM) surface soil samples along with 50 conventional grab samples at Fort Wainwright; 18 ISM and 30 grab samples from Kimama TS; and 27 ISM and 33 grab samples at Fort Eustis. The ISM involves changes both to

the field sampling approach and to laboratory sample preparation procedures. Field sampling using ISM includes collecting multiple sample increments, using a systematic random approach, combined to form a single sample. Modifications to the standard USEPA Method 3050B for digestion of soils for metals analysis, implemented during sample preparation, included air drying, milling, greater acid to soil digestion ratios, larger digestion mass, and subsampling to build the digestate sample. The performance criteria used to determine whether ISM provided technically defensible data were (1) obtain reproducible results for surface soil samples containing metal particles, (2) show improved performance of ISM as compared with conventional grab sampling techniques coupled to the standard USEPA Method 3050B for sample preparation, and (3) demonstrate the ease of ISM implementability.

Through the demonstration at the three field sites, we assessed the utility of multi-increment sampling versus traditional grab/discrete sampling and found that at all sites it yielded reproducible and more representative metals soil concentrations than the conventional grab sampling methods. The variability in metal concentrations as measured with replicate samples and evaluated by the percent relative standard deviation (RSD) was typically less than 10% for all metals using ISM. In contrast, RSDs were often greater than 50% for replicate samples collected following the conventional grab sampling practices. In addition, the calculated mean for ISM metal concentrations was usually statistically greater than the mean for samples using the conventional grab sampling techniques. ISM generally met the performance metrics for this project whereas the conventional approach was unable to meet the performance metrics in most cases.

Distributional heterogeneity is addressed by collecting at least 30 to 100 increments over the entire Decision Unit (DU) using systematic or simple random sampling. Owing to the large number of increments collected within a DU, multi-increment sampling tends to result in better spatial coverage and greater (and therefore more representative) sample mass (greater than 1 kg) for laboratory analysis than conventional grab sampling designs, which typically entail a comparatively small number of grab samples (e.g., n = 10 to 20) of small mass (less than 200 g). However, multi-increment field sampling is insufficient in and of itself to overcome the distributional and compositional heterogeneity in the soil samples. Modifications to laboratory sample preparation procedures of USEPA Method 3050B are also necessary to reduce variability owing to sample heteroge-

neity. The proposed changes for metals adopted many of the recommendations for energetics outlined in USEPA Method 8330B, such as air drying, milling, greater acid to soil digestion ratios, larger digestion mass, and subsampling to build the digestate sample. In general, the demonstration results met the targeted performance criteria using ISM. However, there were instances where the performance criteria were not met (e.g., copper). In these situations, the results indicate that the ISM approach used did not adequately deal with the extreme contaminant heterogeneity. Consequently, in some situations, an iterative approach may be necessary whereby the ISM process is modified to meet the performance objectives (e.g., increasing the milling interval, increasing the number of increments collected, increasing the digestion mass, etc.).

Processing steps that are necessary to control the sample heterogeneity and are best done in the controlled environment of an environmental laboratory include the following:

1. Machining or grinding the soil.
2. Increasing the digested mass and the digestion interval.
3. Improving digestion efficiency by increasing the acid to soil ratio.
4. Subsampling to build the digestate sample.

If metal residues are present in the sample, it is necessary to mill the sample to reduce the size of the metal fragments present in the soil to a common particle size. Without milling, there will usually be large variability, resulting in unreliable estimates of anthropogenic metal concentrations.

Two types of milling equipment yielded satisfactory results: the ball mill and the puck mill. Milling for 5 min with a puck mill is sufficient to reduce the total sampling error to less than 30% for field replicates and to less than 15% for laboratory replicates, except for copper (Cu). Similar levels of total sampling error resulted from using the ball mill for 18 hr. One issue to be aware of when using a puck mill, which contains metallic components, is possible cross-contamination of the soil sample. The principal metals identified as coming off of the puck mill are aluminum (Al), chromium (Cr), and iron (Fe). However, metal cross-contamination is not a particular concern for the small-arms range metals (antimony [Sb], Cu, lead [Pb], and zinc [Zn]). If metal residues composed of Al, Cr, and Fe are expected, then using the ball mill or a puck mill with an agate bowl and puck would be preferable. Otherwise, using the puck mill with metallic

components would require studies using control materials to quantify the amount of metal contribution (Al, Cr, and Fe) from the bowl and puck to the soil sample.

Other sample processing changes evaluated during the digestion step, such as digestion mass (greater than 2 g) and digestion interval, had little bearing on the measured metal values. In addition, it is known that Sb recoveries are poor with guidance provided in USEPA Method 3050B; and therefore, an alternative method involving the addition of hydrochloric acid (HCl) to the method was tested to improve sample recoveries. In some cases, tungsten (W) may be of interest because it is a component of some small-arms ammunition; and recoveries with the standard 3050B Method are also poor. An alternative method tested involved the addition of phosphoric acid (H_3PO_4). Consequently, in some situations, it may be necessary to perform multiple digestions of the same sample to obtain the desired metal analytes.

The authors of this report are currently working with the USEPA to modify Method 3050B to incorporate the recommended changes identified from this project into a Method 3050C. These changes include both modifying the sample preparation methods and incorporating an Appendix outlining the multi-increment sampling approach, similar to what was done with USEPA Method 8330B.

There are no known limitations to the application of ISM because the equipment used is the same as that used with the conventional grab/discrete sampling approach. The implementation costs are lower with ISM as compared to the conventional sampling approach because it involves collecting fewer samples, resulting in

1. The need for fewer sample supplies.
2. Less time for selecting sample locations.
3. Fewer locations surveyed.
4. Decreased field sample preparation activities—labeling, paperwork, etc.
5. Collection of a smaller number of samples.
6. Fewer samples shipped to the laboratory.
7. Smaller number of samples requiring sample preparation.
8. Fewer number of samples analyzed.

It is true that multiple increments are collected to yield a single sample, requiring more collection time than an individual grab/discrete sample; however, once the DU corners are surveyed there is no need to survey individual sample increment locations. In contrast, each grab/discrete sample location requires surveying. In addition, ISM samples typically have a larger mass then conventional grab samples, resulting in greater per sample shipping costs and sample preparation fees. However, the greatest cost savings is incurred at the laboratory preparation step due to the decreased number of samples requiring preparation and analysis. Again, some additional costs are incurred with the addition of the milling and subsampling step. However, the increased costs are more than offset by the fewer number of ISM samples collected as compared to the conventional grab sampling method. Thus, per sample costs are higher with ISM; but total soil-sampling project costs are lower with ISM than with the conventional grab/discrete approach.

Cost savings are difficult to quantify since there is no standard procedure for determining the number of soil samples to be collected from a defined area. The conventional approach for sample location identification is largely subjective and arbitrary and dependent upon the stakeholders involved in the project. However, based on a review of current practices, case studies, and the results of the demonstration at the three sites, using ISM creates a potential cost savings of 30%–60% as compared to conventional sampling approaches.

1 Introduction

Since the publication of United States Environmental Protection Agency (USEPA) Method 8330B (USEPA 2006) for explosives, there have been efforts to develop incremental sampling methodologies (ISMs) for other analytes, particularly metals. However, there are no published procedures for the laboratory processing of incremental samples for analytes other than energetic compounds. Sample collection and laboratory processing procedures for ISM depend on the nature of the analytes of interest. The laboratory procedures of Method 8330B, which were developed specifically for explosives and propellants, generally need to be modified for other analytes. For example, the drying, sieving, and milling procedures for soil samples described in Method 8330B are inappropriate for volatile organic compounds. Depending on the types of analytes of interest, milling can bias analytical results because of analytes losses or the addition of spurious contaminants. However, because milling increases precision, the larger improvements in precision may outweigh the magnitude of the biases. Prior to using ISM, the project's objectives, the nature of the analytes, and the environmental media of interest need to be considered on a case-by-case basis during project planning.

After the release of USEPA Method 8330B, a growing concern within the United States Department of Defense (DoD) and in Federal and State agencies has been the need for similar protocols for the characterization of metals on training ranges and at other locations. A variety of metals are used in military munitions. For example, the casing materials for most artillery and mortar projectiles consist of iron (Fe) and manganese (Mn), and the predominant metal in the anti-tank rockets is aluminum (Al). The metals of interest at small-arms ranges are primarily antimony (Sb); copper (Cu); lead (Pb); zinc (Zn) (Clausen and Korte 2009a); and in some situations, tungsten (W) (Clausen and Korte 2009b; Clausen et al. 2010, 2007). Pyrotechnic devices contain metal constituents, such as Al, Sb, barium (Ba), boron (B), cerium (Ce), chromium (Cr), Cu, Fe, Pb, magnesium (Mg), Mn, potassium (K), sodium (Na), strontium (Sr), titanium (Ti), W, zirconium (Zr), and Zn (Clausen et al. 2012a). As munitions containing metals are frequently used on Army training lands, metals deposited by rounds can accumulate in soils. Although the deposition of metals at mili-

tary ranges has only been studied on a limited basis, metal deposition appears largely spatially heterogeneous, similar to the distribution of explosives. Anthropogenic metals are heterogeneously distributed over training ranges as particles of various sizes, shapes, and compositions. To obtain representative samples (i.e., to ensure mean contaminant concentrations in the samples will be similar to the mean concentrations in the environmental population) and to obtain reproducible estimates of the mean, the sampling design and laboratory analytical methods need to address compositional and distributional heterogeneity.

1.1 Background

The development of ISM began with the realization in the mid-1990s that energetic residues were heterogeneously distributed on ranges and that the current sampling methodologies did not address this issue. Consequently, early studies of energetics yielded non-reproducible and non-representative results, the result being that some sites potentially underwent remediation that was not necessary; or conversely, some sites implemented no needed remedial activities. Studies conducted in the early 2000s resulted in the development of a modified sample collection and processing methodology for energetic constituents, referred to as ISM.

Anthropogenic metals are also heterogeneously distributed over active training ranges as particles of various sizes, shapes, and compositions (Fig. 1). To address the compositional and distributional heterogeneity (e.g., to obtain a representative and reproducible estimate of the mean concentration), the sampling strategy must acquire an adequate number of particles of the constituents of interest; and these particles must be present in the sample in roughly the same proportion as in the Decision Unit (DU). The DU is an area of interest about which one plans to make some decision based on the outcome of the data. The ISM approach is not limited to laboratory sample processing; it also includes field sampling procedures and project planning (Table 1).

Figure 1. Visible small-arms metal debris (yellow circles) found on a small-arms range at Camp Edwards, Massachusetts.

Table 1. Incremental sampling methodology for metallic residues.

<table>
<tr><th>Project Stage</th><th colspan="3">Specific Activity</th></tr>
<tr><td rowspan="6">Project Planning</td><td colspan="3">Development of conceptual site model</td></tr>
<tr><td colspan="3">Determination of investigation objectives</td></tr>
<tr><td colspan="3">Identification of data needs</td></tr>
<tr><td colspan="3">Decision Unit identification</td></tr>
<tr><td colspan="3">Determination of sample depth interval</td></tr>
<tr><td colspan="3">Number of increments per sample</td></tr>
<tr><td rowspan="3">Field Implementation</td><td colspan="3">Sample tool selection</td></tr>
<tr><td colspan="3">Decision Unit delineation</td></tr>
<tr><td colspan="3">Collection of soil sample</td></tr>
<tr><td rowspan="7">Sample Processing</td><td colspan="3">Air drying</td></tr>
<tr><td colspan="3">Sieving</td></tr>
<tr><td colspan="3">Particle size reduction (milling)</td></tr>
<tr><td colspan="2">Less than 2 mm (examined)</td><td rowspan="5">Greater than 2 mm (examined and archived)</td></tr>
<tr><td colspan="2">Splitting (if necessary)</td></tr>
<tr><td colspan="2">Subsampling to build digestate</td></tr>
<tr><td>Metals digestion</td><td>Energetics extraction</td></tr>
<tr><td>Analysis</td><td>ICP-MS or ICP-OES</td><td>HPLC</td></tr>
</table>

ICP-MS—inductively coupled plasma–mass spectrometry

ICP-OES—inductively coupled plasma–optical emission spectrometry

HPLC—high performance liquid chromatography

The first component of ISM involves project planning to determine the

1. Conceptual site model (CSM).
2. Project's objectives.
3. Data needs.
4. DU configuration.
5. Sampling depth.
6. Number of increments per sample (ITRC 2012).

The soil samples from DUs should be physically collected only after the planning phase has been completed.

To reduce the influence of compositional and distributional heterogeneity when estimating the mean concentration of an energetic analyte within a DU, Method 8330B recommends collecting 30 or more evenly spaced increments to build a sample with a total sample mass greater than 1 kg (Jenkins et al. 2004a,b, 2005a, 2006; Walsh et al. 2005; Hewitt et al. 2005, 2007). The objective of this sampling technique is to obtain a representative portion of every particle size, composition, and configuration (e.g., spheres or elongated particles) and to avoid over- or under-sampling any portion of the DU. This same situation applies to small-arms ranges where residues of Sb, Cu, Pb, Zn, and others are present. Instead of collecting and analyzing individual grab samples and integrating the results over an area of interest (DU) or assuming that a single point represents the entire area, samples are prepared by combining a number of increments of soil from within the DU to obtain an approximately 1-kg sample. The increments can be collected using simple random sampling or systematic random sampling. For systematic random sampling, the sampler selects a random starting point and collects evenly spaced increments as the sampler walks back and forth from one corner of the Decision Unit to the opposite corner (Fig. 2).

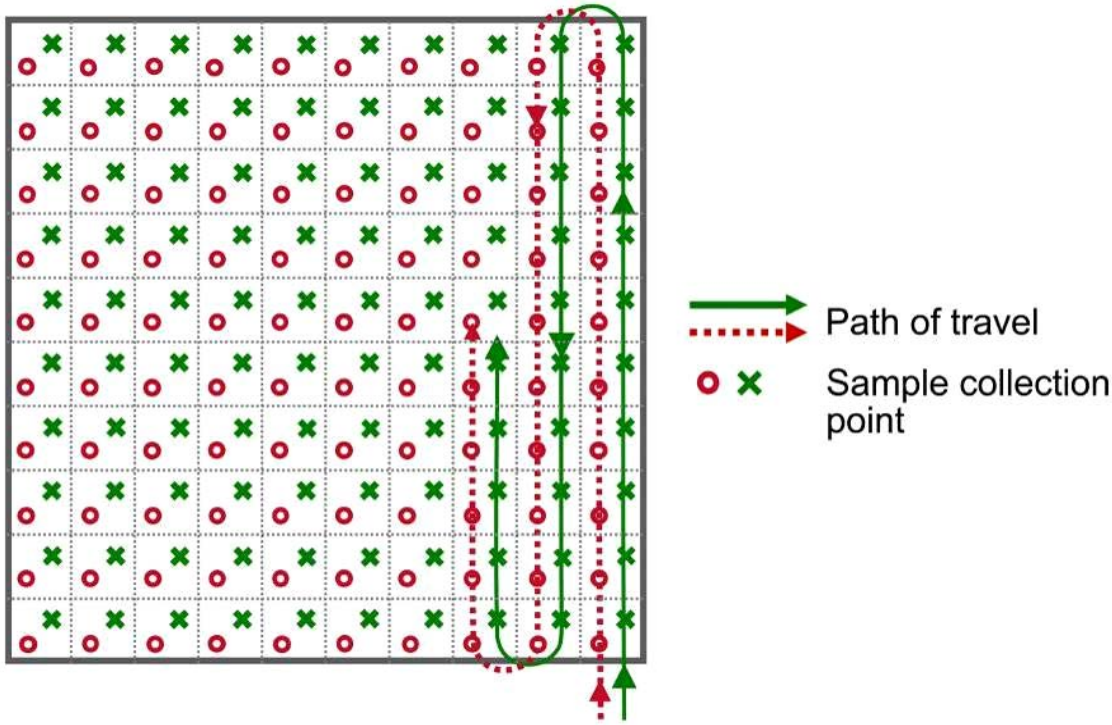


Figure 2. Example of multi-increment sampling using a systematic-random sampling design for collecting two separate 100-increment samples.

The laboratory ISM components include air drying, milling, sieving, subsampling, digestion, and analysis. The potential benefits of ISM as compared to conventional grab or discrete sampling include

1. Collecting a fewer number of soil samples, thus, resulting in fewer samples undergoing laboratory preparation and analysis.
2. Reproducible results.
3. Results representative of the mean concentration for the area of interest, typically referred to as the DU or sampling unit (SU).
4. Quantifying the total sample error and, if desired, the error associated with specific ISM steps.
5. Lower total project soil sampling costs.

1.2 Objective of the demonstration

The objective of this demonstration was to confirm that the ISM approach, as compared to conventional grab/discrete sampling, improved data quality for metallic residue constituents in surface soil samples. Specifically, we wanted to demonstrate that

1. Using ISM provides reproducible results.
2. Milling of soil for the analytes of interest (antimony, copper, lead, and zinc) does not lead to bias.
3. Application of ISM yields sample results more representative of the mean soil concentration than do conventional grab samples.
4. ISM involves lower total project soil sample costs.

Further, we wanted to demonstrate the robustness of ISM with a variety of soil types, thus the selection of three field sites for the demonstration. The working hypothesis was that the current field sampling and sample processing procedures for metals in soil do not yield representative and reproducible results for military sites where the metal was heterogeneously introduced into the environment as a solid residue.

1.3 Regulatory drivers

In 2001, the Defense Environmental Restoration Program established the US Army's Military Munitions Response Program (MMRP) to manage the environmental and health and safety issues associated with unexploded ordnance (UXO), discarded military munitions, and munitions constituents on non-operational ranges in active installations, Defense Base Realignment and Closure (BRAC) sites, and Formerly Used Defense Sites (FUDS). Under the MMRP, the DoD is required to (1) inventory non-operational ranges that contain or are suspected to contain munitions-related material released before September 2002; (2) identify, characterize, track, and report data on MMRP sites and clean-up activities; and (3) develop a process to prioritize site cleanup and to estimate costs. The Army completed their inventory of non-operational ranges in 2003 and began Site Investigations (SI) for these MMRP sites. Based on the SI findings, some ranges may require additional assessment under the Remedial Investigation process. In addition, established directives mandate all active DoD facilities implement procedures to assess environmental impacts from munitions on training and testing ranges (DoD 2007, 2005).

Environmental studies of military training ranges have shown that energetic residues are heterogeneously distributed. Using ISM is necessary to representatively sample military ranges where energetic residues have been introduced into the environment (Hewitt et al. 2009). Consequently, the environmental regulatory community is growing to accept ISM and as-

sociated sample processing procedures for energetics (ITRC 2012; Alaska 2009; Hewitt et al. 2009; Hawaii 2008). USEPA Method 8330B incorporates the use of multi-increment sampling (USEPA 2006).

Because of the success of ISM for energetics, members of the environmental community are increasingly requiring its adoption for other hazardous particulate constituents, such as metals (ITRC 2012; Alaska 2009; Hewitt et al. 2011, 2009; Hawaii 2008). The approach is frequently used for SIs conducted under FUDS. The USEPA has issued guidance for characterizing MMRP sites using ISM (Hewitt et al. 2011) as has the US Army Corps of Engineers (USACE) (USACE 2009). Several state and federal agencies now require ISM designs. These currently include the states of Alaska, Hawaii, and the USEPA Region 6. Other states, such as Florida, are considering rewriting their environmental regulations to require ISM. Additionally, in Massachusetts, Michigan, Missouri, and New Jersey, formal guidance is not available; but in some situations, where appropriate, these states require ISM. The ITRC anticipates that additional states and USEPA regions will increasingly require ISM, thus requiring DoD MMRP and Operational Range Assessments (ORAP) to employ ISM.

2 Technology

2.1 Technology description

The technology demonstrated is the use of ISM to characterize surface soil in an area of interest, DU, containing metallic residues from training with military munitions constituents. The first component of ISM involves project planning to determine the

1. CSM.
2. Project's objectives.
3. Data needs.
4. DU configuration.
5. Sampling depth.
6. Number of increments per sample (ITRC 2012).

Figure 3 is a flowchart showing the entire ISM process. The soil samples from DUs should be physically collected only after the planning phase has been completed.

In the field, the first step is to define the boundaries of the DU with markers (typically flags or stakes). Then, the next step is to determine the approximate spacing between increments (e.g., if increments are collected using systematic random sampling) and the number of rows of increments needed to achieve the total number of increments for each ISM sample. Once the DU is identified, distributional heterogeneity can be addressed by collecting a 1- to 2-kg incremental sample prepared from at least 30 to 100 "increments" collected randomly over the entire DU (Fig. 2). The objective of this sampling technique is to obtain a representative portion of every particle size, composition (Sb, Cu, Pb, Zn, etc.), and configuration (e.g., spheres or elongated particles) and to avoid over- or under-sampling any portion of the DU.

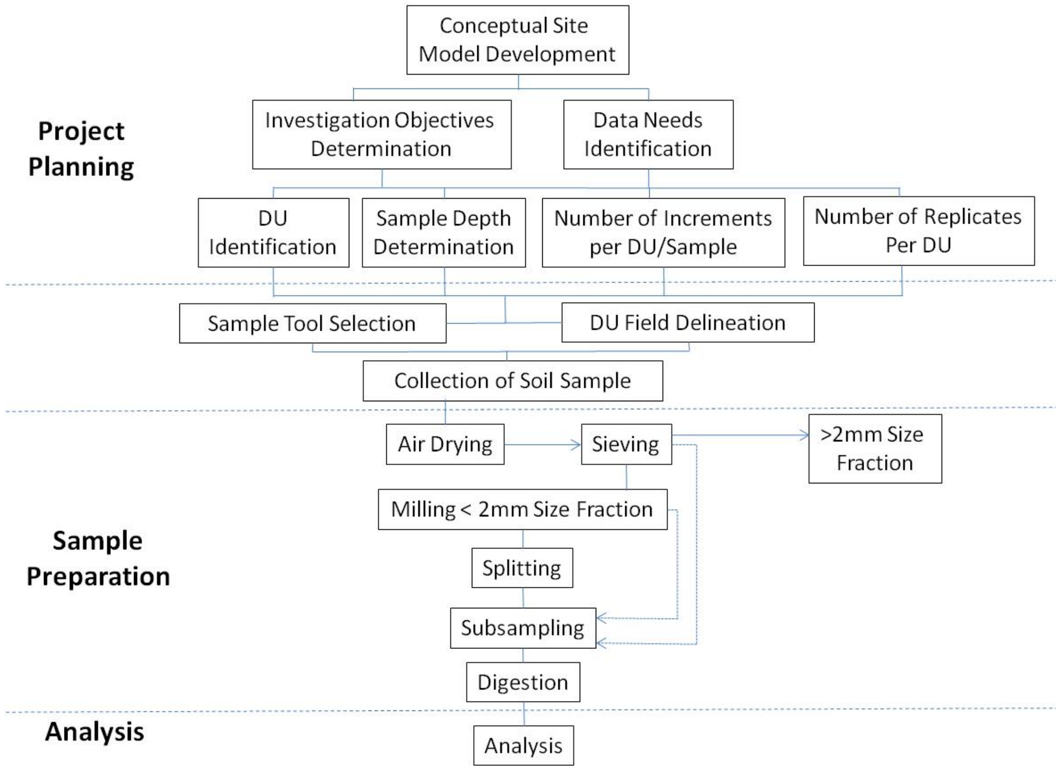


Figure 3. Flowchart of the ISM process.

Traditionally, the analysis of metals in the environment has relied on much smaller samples. A "grab," or individual discrete sample of several hundred grams, is typically collected in a 4-oz amber-glass jar, from which only a small portion is removed; a 0.5 to 2 g aliquot is often scooped from the top of the jar for extraction (acid digestion) by Method 3050B or Method 3051A (USEPA 1996a,b). Instead of collecting and analyzing individual grab samples and integrating the results over an area of interest (DU) or assuming that a single point represents the entire area, ISM samples are prepared by combining a number of increments of soil from within the DU. The increments can be collected using simple random sampling or systematic random sampling. For systematic random sampling, the sampler selects a random starting point and collects evenly spaced increments as the sampler walks back and forth from one corner of the Decision Unit to the opposite corner (Fig. 4).

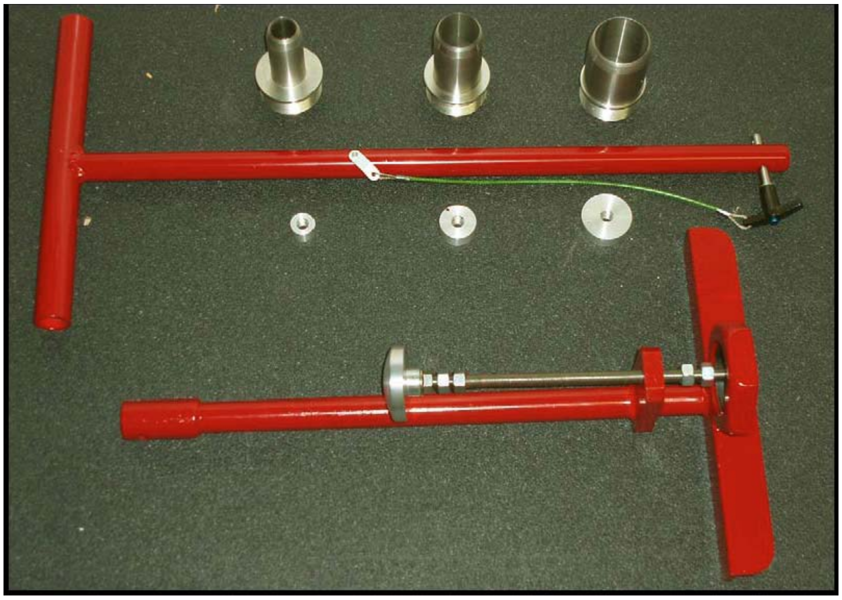


Figure 4. The CRREL Multi-Increment Sampling Tool (CMIST). Coring tips are 2-, 3-, and 4-cm diameter (left to right). Corresponding disks are shown below the handle.

As used in this document, the term “Sampling Unit” (SU), which is also commonly referred to as the DU, refers to an environmental population (e.g., some specified volume or soil mass) from which independent incremental samples are randomly collected. The “increments” that are combined to prepare each incremental sample typically refer to cylindrical soil cores that are collected using a coring device such as the “Cold Regions Research and Engineering Laboratory (CRREL) Multi-Increment Sampling Tool” (CMIST) (Walsh 2009) (Fig. 3).

It is critical to collect a sufficient number of independent replicate incremental samples to confidently characterize the total variability of the mean metal concentrations. At least three replicates should be independently collected; and when the reproducibility needs to be reliably quantified, a minimum of eight replicates should be collected. If multiple DUs are being evaluated, it may not be necessary to collect replicates for each DU, especially if the DUs are expected to have similar levels of heterogeneity.

If metal residues and energetics are both contaminants of interest and separate incremental samples are not collected in the field for metals and explosives, to control distributional and compositional heterogeneity, each sample must be split in the laboratory in a manner that is consistent with Gy’s sampling theory and practice. At present, a fixed “recipe” for sample

splitting has not been developed. However, using a rotary splitter following drying, sieving, and milling, Clausen et al. (2012b) demonstrated reproducible results for splitting samples containing metal particles. Similar findings were evident following the same methodology for soils containing energetic materials (Hewitt et al. 2009). In general, samples should not be split in the field using a method such as cone and quartering because of its inferior performance compared with other procedures (Clausen et al. 2012b; Gerlach and Nocerino 2003).

If the sample is not milled, the sample will typically need to be split in the laboratory after it is dried and sieved. Standard operating procedures to split, mill, and subsample should be developed on a project-specific basis and should be consistent with the guidance in the American Society for Testing and Materials ASTM D6323 (ASTM 2003a) and EPA 600/R-03/027 (Gerlach and Nocerino 2003). As shown in Clausen et al. (2012b), successful splitting of unmilled samples with a high degree of heterogeneity is not possible even with a rotary splitter where many increments are collected for each split.

Clausen et al. (2012b) discuss protocols for the laboratory processing of incremental samples for metals. In general, when soils contain metal particulates (e.g., bullet fragments), the entire sample should be dried, sieved, and then mechanically pulverized. Table 2 summarizes the proposed changes to the sampling processing procedures for Method 3050B. Incremental samples are first air-dried at room temperature (e.g., for several days) by spreading each sample evenly onto a large tray. After drying, each soil sample is passed through a 2-mm (#10 mesh) sieve and the two fractions are weighed. A 10-mesh sieve is used to separate the fraction less than 2 mm in size for extraction and instrumental analysis. At present, there is inadequate data to determine whether this is the most appropriate particle size threshold for processing soils for metal analyses; but it serves as a "default" criterion for the exclusion of pebbles, twigs, and other larger materials that would typically not be categorized as "soil." Additional particle size reduction is typically needed to obtain reproducible results, as even within the less than 2-mm soil-size class, metallic particles from munitions possess a variety of sizes, densities, shapes, and compositions. Otherwise, compositional heterogeneity will likely result in large variability for the subsample masses that are typically digested and analyzed (e.g., 2 to 10 g).

Table 2. Salient differences between Method 3050B and proposed Method 3050C.

Activity	Method 3050B/ Conventional Sampling	Method 3050C/ Incremental Sampling Method
Field Sampling	Not explicitly addressed in method. Typically, grab samples are collected with a metal scoop from biased sample locations.	An incremental sample consists of 30–100 “increments” collected randomly over the entire Sampling Unit (e.g., using a systematic sampling). For cohesive surface soils, an “increment” typically consists of a small soil cylinder (e.g., 2–5 cm in length) that was collected using a 2- to 4-cm diameter coring device (e.g., as shown in Fig. 2).
Sample Mass and Containers	Typically, about 200 g of soil in 4-oz, wide-mouth, screw-top jars.	Typically, 1–2 kg of soil in clean large (e.g., 15 × 15 in., 6-mm thick) polyethylene plastic bags sealed with Ty-wraps,
Sample Drying	Sample drying is optional and is not typically done.	Sample is air-dried at room temperature by spreading it onto a tray to form a relatively thin uniform slab.
Sieving	“...sieve, if appropriate and necessary, using a USS #10 sieve...” Soil samples are typically not sieved.	Samples are routinely passed through a #10 (2-mm) sieve. Both size fractions are weighed and a less than 2-mm fraction is additionally processed.
Milling	“Wet samples may be dried, crushed, and ground to reduce sample variability...” Milling is typically not done.	Samples are routinely milled using appropriate mechanical grinders, such as puck mill or roller mill. Milling must result in finely ground material of uniform appearance and texture.
Laboratory Subsampling	“Mix the sample thoroughly to achieve homogeneity...” Soil is often stirred with a spatula or a similar device (often in original container), and a single aliquot (e.g., scooped from the top of the container) collected as the subsampled for digestion and analyses.	After grinding, the soil is spread onto a large tray to form a thin slab of material of uniform thickness. At least 20 small aliquots are randomly collected over the entire slab with a spatula or similar device and composited to prepare a subsample for digestion and analysis.
Subsample Mass	1- 2-g wet weight or 1-g dry weight.	2–10-g dry weight.

Unfortunately, unlike for explosives, a “universal” grinder is not currently available for processing incremental samples for metals although Clausen et al. (2012b) obtained good success with the puck mill and roller mill. The grinder needs to be selected on the basis of the metals that are of primary interest for each project. Most commercial crushing or grinding equipment possess working surfaces composed of metal alloys containing Fe, Cr, W (carbide), etc. These grinding surfaces have been demonstrated to introduce metal contamination during sample processing (Clausen et al. 2012b), though Felt et al. (2008) indicate the effect on soil concentrations

is minimal. However, if needed or desired, non-metallic materials are available, such as an agate bowl and puck for the puck mill and Teflon coated cans and ceramic chips for the roller mill. None of the commercial environmental laboratories in the US have an agate bowl and puck available.

Spurious contamination may be significant when the grinding equipment is constructed from the same metals that are contaminants of interest for the environmental samples. For example, metal contamination from the puck mill in Method 8330B has been observed to increase sample Cr and Fe levels by multiplicative factors (Clausen et al. 2012b). Samples should not be ground using a grinder that contains metal surfaces (e.g., the steel puck and bowl of the puck mill described in Method 8330B) unless the external introduction of metal contamination is taken into consideration. The grinding surfaces should not introduce significant quantities of the metals or interferences for project's target analytes (e.g., metal contamination in the method blanks should satisfy the blank acceptance criteria in the DoD Quality Systems Manual or otherwise meet project-specific measurement quality objectives).

There are circumstances in which incremental samples may not be amenable to milling, as some munitions constituent metals in elemental form (e.g. Cu, tin [Sn]) are malleable (Clausen et al. 2012b). Depending on the nature of the grinder selected, malleable particles can smear on milling surfaces. Loses of analytes to milling surfaces can result in significant negative bias. Decontamination of malleable metals from milling equipment can also be problematic, resulting in positives biases from sample-to-sample "carry over" (i.e., cross-contamination). Unfortunately, performance data for various grinders for incremental soil samples containing malleable metal particles (e.g., projectile fragments in a firing range berm) are currently extremely limited. However, if soil samples containing metal particles are not milled, good precision is unlikely to be observed (i.e., when a sufficient number of replicates is processed to accurately characterize precision). Large heterogeneity will likely result in highly positively skewed distributions of measurements that cannot be accurately characterized by a small number of replicates (e.g., duplicates and triplicates).

In theory, compositional heterogeneity may be reduced by increasing the laboratory subsample masses digested and analyzed. However, at concen-

trations on the order of part per million, the amount of mass required for 2-mm particles sizes to achieve reasonable precision will likely be impractical to process. Increasing the subsample mass to 5–10 g (which is frequently the upper range that conventional laboratory equipment used to digest samples can readily accommodate) can reduce the subsampling variability but will not necessarily satisfy measurement quality objectives for precision. Similarly, as large uncertainties arise from compositional heterogeneity (e.g., as measured by the fundamental error), subsampling procedures to minimize distribution heterogeneity, such as the use of a rotary splitter and other techniques described by the American Society for Testing and Materials (ASTM 2003a) and Gerlach and Nocerino (2003), will likely result in only marginal improvements in precision.

Naturally occurring metals in surface soils are almost always found as crystalline silicate, oxide/hydroxide, or carbonate minerals that are amenable to grinding. Traditional geochemical studies have long used mechanical crushing and grinding procedures. However, high energy grinding devices, such as the puck mill, will very likely be needed to obtain reasonable laboratory subsampling precision for soils contain metallic fragments. ASTM (2003) recommends that the subsample mass and particle size reduction be adequate to ensure that the fundamental error is no larger than 15% (ASTM 2003a).

Using incremental samples from uncontaminated native soils, a study of metal concentrations, which used several grinders with non-metallic surfaces, indicated that grinding tends to improves precision but results in a small positive bias for median metal concentrations (Felt et al. 2008). As the study used non-metallic grinders, the positive biases seemed to be owing to surface area increases that helped solubilize metals during the acid digestions. However, grinding seemed to reduce total measurement uncertainty. The improved precision tended to offset the small positive biases (e.g., grinding resulted in small upper 95% confidence limits of the mean owing to improved precision).

If the end use of the data is to assess the risk of incidental ingestion (e.g., of Pb), the concentration of metals in larger particles may be of less interest than the metal concentrations in the finer (less than or equal to 0.25 mm) fraction. Reasonable precision can potentially be obtained without milling if the incremental samples are processed using smaller diameter

sieves. In particular, a finer mesh sieve (0.25 mm) may be used to process incremental soils samples prior to subsampling for lead (USEPA 2000; Gerlach and Nocerino 2003; ITRC 2003). A finer mesh sieve will significantly improve precision as the sieved material will contain smaller particles. However, it is important to note that sieving an unground sample through sieves finer than 2 mm is generally not appropriate for high explosives and propellants. Much of the mass of the energetic analytes is in particles greater than 0.59 mm (30-mesh sieve) (Walsh et al. 2007).

After milling, the soil is spread onto a large tray to form a thin slab of material of uniform thickness. At least 20 small aliquots are randomly collected over the entire slab with a flat edged spatula or a similar device and composited to prepare a subsample for digestion and analysis.

Digestion generally follows the procedures outlined in USEPA Method 3050B with the following changes. Clausen et al. (2012b) recommend that more than 1 g of material be digested, preferably in the 2–5-g range, maintaining a 1:1 ratio of acid to soil. Digestion masses greater than 5 g are potentially problematic due to the potential for foaming or effervescence that overtops the conventional 100-ml vials used with standard digestion blocks. With the differences statistically significant although the magnitude of change was small, Clausen et al. (2012b) found improved sample reproducibility and reduced sample variability with increasing mass.

The ISM discussed above is based on studies starting with energetics (Walsh 2009) and transitioning into metals (Clausen et al. 2012b). Table 3 provides a chronological summary of the development of ISM.

Although our report specifically focuses on the application of ISM at small-arms ranges, it has potential application to any site where solid metallic residues are introduced into the environment. At military installations, this could include impact areas where artillery, mortar, or anti-tank rockets were fired as these munitions contain metals in the ordnance casing. In addition, many pyrotechnic devices contain metallic salts; so if training or maneuver areas are being sampled where these devices have been used, then the ISM is appropriate.

Table 3. Chronological summary of multi-increment sampling.

Time Period	Activity	References
1960s–1990s	Recognition of the role of heterogeneity in distribution of metals in mining samples and development of methods to obtain representative samples	Duncan 1962, Johanson 1978 Elder et al. 1980 Gy 1992, 1999 Wallace and Kratochvil 1985 Pitard 1993 Leutwyler 1993 Studt 1995
Early 1990s–2004	Demonstration of presence of energetic residues on ranges	Racine et al. 1992 Jenkins et al. 1997a,b, 1998, 2001 Walsh and Collins 1993, Walsh et al. 1997 Thiboutot et al. 1998, 2000a,b, 2003 Ampleman et al. 2003a,b Clausen et al. 2004 Pennington et al. 2004 Taylor et al. 2004
1990s	Recognition of heterogeneity issues associated with environmental samples	Pitard 1993 Jenkins et al. 1996
Mid 1990s–Early 2000s	Recognition of heterogeneity issues for energetic constituents on military ranges	Racine et al. 1992 Jenkins et al. 1997a,b, 1999, 2000 Taylor et al. 2004 Walsh and Collins 1993 Walsh et al. 1997
2001–2009	Development of sampling and sample processing methods for soils containing energetic constituents	Jenkins et al. 2001, 2004a,b, 2005a, 2006 Thiboutot et al. 2002 Walsh et al. 2002, 2003, 2005, 2006 Walsh and Lambert 2006 Hewitt and Walsh 2003 Hewitt et al. 2005, 2007, 2009
2004–2007	Demonstration and comparison of ISM with traditional grab sampling approach for soils with energetic constituents	Jenkins et al. 2004a,b Walsh et al. 2004 Hewitt et al. 2005 Nieman 2007
2007–2010	Demonstration of heterogeneous distribution of metals in soils from military ranges	Clausen et al. 2007, 2010 Clausen and Korte 2009a,b
2008–present	Adoption of ISM for soils with metals	Hawaii 2008 Alaska 2009 ITRC 2012
2009–present	ESTCP ER-0918 Project	Clausen et al. 2012b

2.2 Technology development

The current project evaluated potential modifications to field sampling and sample processing procedures to obtain representative samples of soils containing metal residues with the results reported in "*Evaluation of Sampling and Sample Preparation Modifications for Soil Containing Metallic Residues*" (Clausen et al. 2012b). The field issues studied included (1) the need for ISM samples, (2) the performance of ISM versus the traditional grab/discrete sampling method, (3) the optimum number of increments per ISM sample, and (4) the utility and performance of field splitting ISM collected samples. The laboratory processing procedures evaluated included

1. The necessity of milling of the soil sample to reduce the size, to increase the number of contaminant particles in the sample, and to reduce composition heterogeneity.
2. Milling apparatus selection and performance.
3. The appropriate milling interval for the puck mill and roller mill.
4. The effect of digested soil mass on both milled and unmilled samples.
5. The effect of the digestion interval on milled samples.
6. The need for subsampling for digestate preparation.
7. Alternative digestion procedures for antimony.
8. The development of quality control samples.

The following is a brief summary of the technology development findings reported in Clausen et al. (2012b) where the best data quality improvements were incorporated and tested during the demonstration phase of the project and discussed later in the current document. They observed large variability and positive skewed distributions for the grab samples whereas ISM samples exhibited lower variability and an absence of skewed distributions. Replicate ISM soil samples resulted in percent relative standard deviations (RSDs) of less than 30%, suggesting that distributional heterogeneity was reasonably controlled. In contrast, measured RSDs for the grab samples typically yielded values greater than 30% and, in some cases, in the hundreds of percent. Comparing the pooled ISM results with the grab sample results indicated an under estimation of the DU grab sample mean relative to the ISM samples.

One of the questions of performing ISM is how many increments are needed per sample. Soil samples collected from the berm face DU at Range 4-3, located at Camp Ethan Allen, Vermont, consisted of 5, 10, 20, 30, 50, and 100 increments. Seven field replicate samples were collected for each increment value evaluated. A sampling error of less than 30 % was achieved when the number of increments exceeded 30 (Clausen et al. 2012b). Thus, for the situation studied, more than 30 increments were not necessary; but clearly fewer than 30 were inadequate to obtain reproducible results.

Owing to the large number of increments collected within a DU, multi-increment sampling tends to result in better spatial coverage and larger (and therefore more representative) sample masses for laboratory analysis than conventional grab sampling designs, which typically entail a comparatively small number of grab samples (e.g., n = 10–20). However, ISM alone is insufficient to overcome the distributional and compositional heterogeneity in the soil samples. Modifications to laboratory sample preparation procedures are also necessary to reduce variability owing to sample heterogeneity.

To evaluate whether milling was appropriate for soil samples from small-arms ranges, Clausen et al. (2012b) compared an unground sample with a milled (using a puck mill) sample of the same material. The results for Cu, Pb, Sb, and Zn were evaluated in depth as these metals are typically the major constituents of small-arms ammunition. Milling normalized the distributions and increased median metal concentrations but also decreased the variability in results.

Because the samples were milled using the puck mill (which contains metal components) and ball mill, one question is how much does cross-contamination from the milling equipment contribute to the increased metal values. Two possible materials explored were commercially produced glass beads and soda glass obtained from crushing laboratory grade clear-glassware. These materials proved acceptable to assess metal carryover when the beads or glassware were acid washed prior to milling, and pre-milled analysis was performed to obtain a control. However, the one-time use coupled with the cost of glass beads, the hazards of working with broken glassware, and the dissimilarity in hardness with real soils makes these materials less than ideal for a laboratory control. The Clausen et al.

(2012b) studies did indicate a potential for a significant increase in Cr, Mn, nickel (Ni), and vanadium (V) concentrations as a result of cross-contamination from a metallic puck and bowl. However, the potential impact on the metals of interest (Sb, Cu, Pb, and Zn) is minimal. Further, the cross-contamination issue becomes less important as the metal concentration of the sample increases. For Sb, Cu, Pb, and Zn, the potential concentration increase from cross-contamination is less than 5 mg/kg. In contrast, small-arms range bermed soil often has Pb levels, typically the principal metal of interest, in the 100 to 100,000 mg/kg range.

Milling for 5 min (60 s of milling followed by 60 s of cooling) with a puck mill is sufficient to reduce the total sampling error to less than 30% for field replicates and less than 15% for laboratory replicates. Similar levels of total sampling error were associated with milling using the ball mill for 18 hr. A mortar and pestle, which only disaggregates a sample, reduced laboratory subsampling variability as compared to the unmilled sample. However, the percent RSDs of laboratory replicates for samples disaggregated with the mortar and pestle did not generally meet the 15% performance criterion.

Field splitting techniques, such as cone-and-quartering, were ineffective for controlling heterogeneity. Study results yielded order of magnitude differences in metal concentrations for the same ISM sample. Even rotary splitters were inadequate to control sample heterogeneity when soils contained metallic fragments. These findings are consistent with a previous study by Gerlach and Nocerino (2003).

The digestion mass of the sample and the digestion interval were two variables assessed during the sample preparation process following USEPA Method 3050B. Overall decreases for the variance were observed and were statistically significant for Sb and Pb as the digestion mass was increased. Laboratory subsampling precision improved overall as the digestion mass increased, but the changes were nominal with digestion masses greater than or equal to 2 g. Consequently, a 2-g sample mass for digestion seems adequate for most situations.

For the four small-arms metals Cu, Pb, Sb and Zn, statistically significant differences were observed for Sb and Pb only by digestion time. However,

the amount of concentration increase was small, generally less than 10%. Therefore, the recommendation is no changes to the digestion time.

USEPA Method 3050B often yields poor Sb recoveries, typically less than 50% (Nash et al. 2000 Hewitt and Cragin 1992, 1991; Kimbrough. and Wakakuwa 1992, 1989). This is primarily because some of the Sb is insoluble as a result of passivation and chemical bonding with the soil particles. A method involving the addition of hydrochloric acid (HCl) yielded improved Pb and Sb recoveries and significantly reduced the total sampling error as calculated with the percent RSD. The Sb recoveries with the modified 3050B Method were statistically significant as compared to the standard 3050B Method.

2.3 Advantages and limitations of the technology

The advantages of ISM include (1) a soil sample representative of the area of interest (i.e. DU), (2) the ability to quantify the uncertainty for field sampling and laboratory sample and analysis, and (3) a reduction in the number of field samples collected for laboratory analysis (Table 4). The disadvantages of ISM include (1) an increased volume of individual samples sent to the analytical laboratory; (2) the necessity of a particles size reduction step (e.g., milling, during sample preparation); and (3) the alteration of the soil matrix during the particle size reduction step, possibly changing the availability of some metals during acid digestion (Table 4).

Table 4. Comparison of the advantages and disadvantages of the Incremental Sample Methodology.

Activity	Advantages	Disadvantages	Comment
Total Sample Error	☑		Quantification of error possible with ISM
Number of Soil Samples	☑		Fewer samples needed with ISM
Individual Sample Mass		☑	Greater sample mass to handle heterogeneity
Precision of Result	☑		Greater sample result precision with ISM
Laboratory Preparation		☑	More involved with ISM (drying, milling, subsampling)
Field Costs	☑		Fewer samples to collect and ship with ISM
Sample Preparation Costs		☑	Higher costs due to more involved processing

Activity	Advantages	Disadvantages	Comment
Soil Matrix Alteration		☑	Possible changes to metal recovery due to milling
Milling Cross-Contamination		☑	Possible metal cross-contamination from milling when using metallic components
Metal Ratios Analysis		☑	The averaging effect of ISM is not conducive for metal ratio analysis

The current soil sampling methodology involves using random or systematic sampling to collect grab or "discrete" surface soil samples. Previous work conducted during Task 1 of this study and in other studies with energetic contaminants has demonstrated that grab samples do not yield a sample representative of the area of interest. The mean is typically biased low.

Processing of soil samples so that they can be reproducibly subsampled often involves a particle size reduction step, such as milling. Increasing the surface area of a soil matrix may make some metals more available for acid digestion. A recent study using three soil types and three grinding techniques compared results with those obtained for samples that were blended without pulverization. Overall, the milling step increased precision and only slightly increased metal concentrations (Felt et al. 2008). One potential drawback is that samples from areas of concern (DU) and from background locations will need to be collected and processed using the same protocols. This requirement may increase the number of samples collected, processed, and analyzed, thereby increasing costs as compared to using conventional approaches.

However, it is noted that, because of larger variability, conventional sampling designs often result in collection of an inadequate number of samples, resulting in large data variances and making reliable quantitative statistical comparisons difficult. Background comparisons using ISM can often be done using smaller numbers of samples sizes as the approach tends to reduce the variability and to normalize distributions. It is anticipated that the use of ISM will significantly increase the data quality of background samples (Clausen et al. 2012b).

In contrast, large variability and positive skewed distributions are normally observed for grab samples. In addition, ISM yielded highly reproducible

results and high precision with percent RSDs of less than 30% for replicate samples, suggesting that distributional heterogeneity was reasonably controlled. In contrast, measured RSDs for the grab samples typically yielded values greater than 30% and, in some cases, in the hundreds of percent. The results of the demonstration study also suggested that ISM improved the accuracy of estimates of the mean; grab samples often underestimate the population mean. In general, the ISM results exhibit a higher mean concentration than grab sample results. For the metals of interest (Cu, Pb, Sb, and Zn), this situation occurred in 60% of the sample results for the three demonstration sites and the one experimental site. In instances where the ISM mean was less than the grab sample mean, the data exhibited greater variability than desired. It seems likely that sample precision and accuracy could have been improved by taking all or some of the following steps: (1) increasing the number of increments collected from the DU, (2) increasing the sample mass collected from the DU, (3) increasing the number of subsampling increments to build the digestion aliquot, and (4) increasing the digestion mass. One of the advantages of ISM is the ability to assess the total sample error or the error associated with specific steps of the ISM process, allowing for the establishment of performance criteria. If the criteria are not met initially, the ISM process can be altered to meet one's sample quality objectives.

One of the limitations of ISM is the necessity of collecting, at minimum, 30 increments from the DU; otherwise, collecting fewer than 30 increments results in poorer data precision (Clausen et al. 2012b). An RSD of less than 30% was generally achieved when the number of increments exceeded 30. However, fewer than 30 increments collected resulted in an RSDs greater than 30%. Thus, for the situation studied, more than 530-increments were not necessary, but clearly fewer than 30 were inadequate to obtain reproducible results. Additionally, owing to the large number of increments collected within a DU, ISM tends to result in better spatial coverage and larger and, therefore, more representative samples than the conventional grab sampling approach. However, ISM alone is insufficient to overcome the distributional and compositional heterogeneity in the soil samples. Modifications to laboratory sample preparation procedures are also necessary to reduce variability owing to sample heterogeneity (Clausen et al. 2012b).

Another potential limitation is that the typical puck mill used by commercial environmental laboratories contains metal components. Studies by

Clausen et al. (2012b) indicated a potential for a significant increase in Cr, Mn, Ni, and V concentrations as a result of cross-contamination from a metallic puck and bowl. However, contamination from the puck mill seems minimal for the small-arms range metals Sb, Cu, Pb, and Zn (Clausen et al. 2012a; Felt et al. 2008). Further, the cross-contamination issue becomes less important as the metal concentration of the sample increases, resulting in greater separation from a regulatory action level. For Sb, Cu, Pb, and Zn, the potential concentration increase from cross-contamination resulting from milling is less than 5 mg/kg. This may be problematic in situations where the expected DU soil concentration is within several mg/kg of an action level. However, cross-contamination issues can be avoided by using an agate puck and bowl although these are more expensive than the metallic versions and process less material owing to their smaller size. Another alternative is the use of a Teflon-lined roller mill with Teflon chips, which yielded acceptable results (Clausen et al. 2012b). It should be kept in mind that many of the small-arms range bermed soils we have sampled often have lead levels, typically the principal metal of interest, in the 1000s to 100,000s mg/kg range; but the decision limit for lead is often only 400 mg/kg.

3 Performance Objectives

There are three quantitative performance objectives and one qualitative performance objective for the demonstration and validation of the technology (Table 5). The quantitative performance objectives are sample reproducibility, lack of sample bias, and cost reduction. The qualitative performance objective is ease of technology use. The effectiveness of the technology for soil sampling is predominately a function of the precision of replicate laboratory subsample results from the same field ISM sample and the precision of replicate field ISM sample results from the same DU. We evaluated ISM's effectiveness by collecting replicate ISM soil samples from each DU and comparing them against multiple grab samples collected from the same DU. We collected fifteen replicate ISM samples at the small-arms firing range berm DU at the three sites: Fort Wainwright, Fort Eustis, and Kimama Training Site (TS). From the same DUs, we collected 50 grab samples from Fort Wainwright, 30 from Kimama TS, and 33 from Fort Eustis. Using statistical comparisons at the 95% level of confidence, the team performed an evaluation of sample variability. The null hypothesis is no difference between the variances of the population of grab and ISM samples. The results indicated a significant difference between variances for the two populations with lower variances evident for ISM as compared to grab samples. A secondary goal was to achieve a percent RSD of less than or equal to 30% for field replicates from the same DU and less than or equal to 15% for laboratory subsample replicates with ISM. ISM met this objective, but the grab sampling approach did not.

We also evaluated positive bias (e.g., owing to milling during sample preparation) by processing method blanks consisting of glass material. Glass samples were milled before and after a batch of soil samples were milled. A total of 7 soil samples were processed in this manner. We evaluated bias by using the criteria summarized in Table 5. For the metals of interest (Cu, Pb, Sb, and Zn) there was no evidence of an increase in the glass blank samples between pre- and post-milled samples. We also processed Laboratory Control Samples (LCSs) with each sample batch to evaluate bias. Again there was no evidence of sample bias for the analytes of interest.

Table 5. Performance objectives for ER-0918.

Performance Objective	Data Requirements	Success Criteria	Performance Objective Met
Quantitative Performance Objectives			
Obtain reproducible results for surface soil samples containing metal particles	Field and laboratory replicates analyzed for metals.	Demonstrate statistically significant decreases for variability (with 95% confidence) for replicate field samples and replicate laboratory subsamples compared with replicates processed using conventional methodology.	Yes
		RSD $\leq$ 30% for field replicates within same DU	Yes
		RSD $\lesssim$ 15% for lab replicates (for concentrations > 100 mg/kg)	Yes
Evaluate bias	Method blanks (MBs) and laboratory control samples (LCSs) processed with ISM.	Concentrations < $^{1}/_{10}$ the ISM sample concentrations. LCS recoveries should be 70%–130% of the expected values or of the manufacturer's specifications.	Yes
Compare performance of ISM sampling and grab sampling for metals in soils	Samples collected using multi-increment sampling approach and grab sampling designs. Hours or cost of field sampling effort and of sample preparation and analysis recorded.	ISM sampling design results in equivalent or superior estimates of the mean with less analyses and results in a cost savings of at least 20%.	Yes
Qualitative Performance Objectives			
Implementability	Feedback collected from field and laboratory personnel.	ISM sampling approach can be readily implemented given appropriate equipment and planning.	Yes

The third quantitative performance objective is that ISM yields a total reduction in cost of 20%. Total reduction refers to consideration of both physical collection of soil samples in the field and sample preparation back in the laboratory. The team evaluated this objective by monitoring the manpower and length of time needed for

1. Field mobilization preparation.
2. DU/sample location determination and flagging.
3. Surveying of sample locations/DU.
4. Physical collection of samples.
5. Shipping costs of samples.
6. Sample preparation costs.
7. Sample analysis.

Sample preparation activities assessed the unmilled approach following USEPA Method 3050B and the milled approach following our modified Method 3050B approach, referred to as Method 3050C. We performed these activities for both ISM and grab samples. The outcome of this cost comparison is that total ISM costs are 20% less or more as compared to the conventional grab sampling approach.

Because the number of grab samples collected for a given area is subjective and no two individuals necessarily agree, environmental consultants experienced with SI and Remedial Investigation (RI) were polled for a hypothetical small-arms range berm. The consensus seems that for a 3-m-high by 100-m-long berm, 7 to 10 grab samples would be appropriate although those with a statistical background and training preferred even more grab samples. However, precision and presumably accuracy (for estimating the DU mean) for grab sampling significantly decreases as the sample size decreases and is usually poor relative to that provided by an equal number of incremental samples. As ISM and conventional judgmental sampling designs using grab samples do not result in comparable data quality, comparisons based solely on the per-unit costs of sampling and analysis do not accurately reflect the true cost of ISM relative to conventional sampling.

Implementability is a qualitative performance objective that assesses feedback from field and laboratory personnel about the ease of use of ISM. Ease of use also includes availability of tools to implement the ISM and sample processing procedures. The discussions about field sampling indicate little difference between ISM and the conventional grab sampling approach as the same field equipment is used for both. The only major difference during sample preparation in the laboratory is with milling the sample. Implementation of this step is limited in the sense that the majority of commercial environmental analytical laboratories do not have milling equipment. However, for those laboratories that have milling equipment, the ISM approach is readily implementable.

4 Site Description

Instead of conducting the demonstration and validation at a single site, we conducted the demonstration and validation at three sites to ensure robustness of the technology. The three sites selected and discussed below are Kimama TS in ID, Fort Eustis in VA, and Fort Wainwright in AK.

4.1 Site location and history

4.1.1 Kimama Training Site

The Kimama TS is located in south-central Idaho in Lincoln County, approximately 17 miles northwest of Minidoka off Highway 24, and was used by the Idaho Army National Guard for training (Fig. 5). The Kimama TS was established on 13 September 1968 when the Bureau of Land Management (BLM) issued Special Land Use Permit #I-2407 to the USACE for approximately 63,826 acres. Later, according to the Special Land Use Permit (Listing #1), 3840 acres were acquired from the State of Idaho and an additional 1280 acres of BLM land were added for a livestock driveway. A total of 68,946 acres were originally authorized for Kimama TS use from 1968 to 1972 (FPM 2009). The Kimama TS has been formally known as Kimama Weekend Training Site, Idaho State National Guard Training Area, Kimama Training Area, Shoshone National Guard Maneuver Area, Kimama-Carey National Guard Maneuver Area, and Kimama Firing Range. A 1972 amendment to the Special Land Use Permit granted the construction of a tank compound, the reduction and change in acreage to 23,549 acres, and the establishment of three separate training areas to be used approximately every weekend from early March through November with a three-year rotation schedule. This rotation schedule enabled training areas to be reseeded and rehabilitated prior to continued use. The only exceptions to the rotation were the small-arms firing ranges located within Training Area 3 (Fig. 6), used periodically every year for marksmanship training and for small-arms qualification.

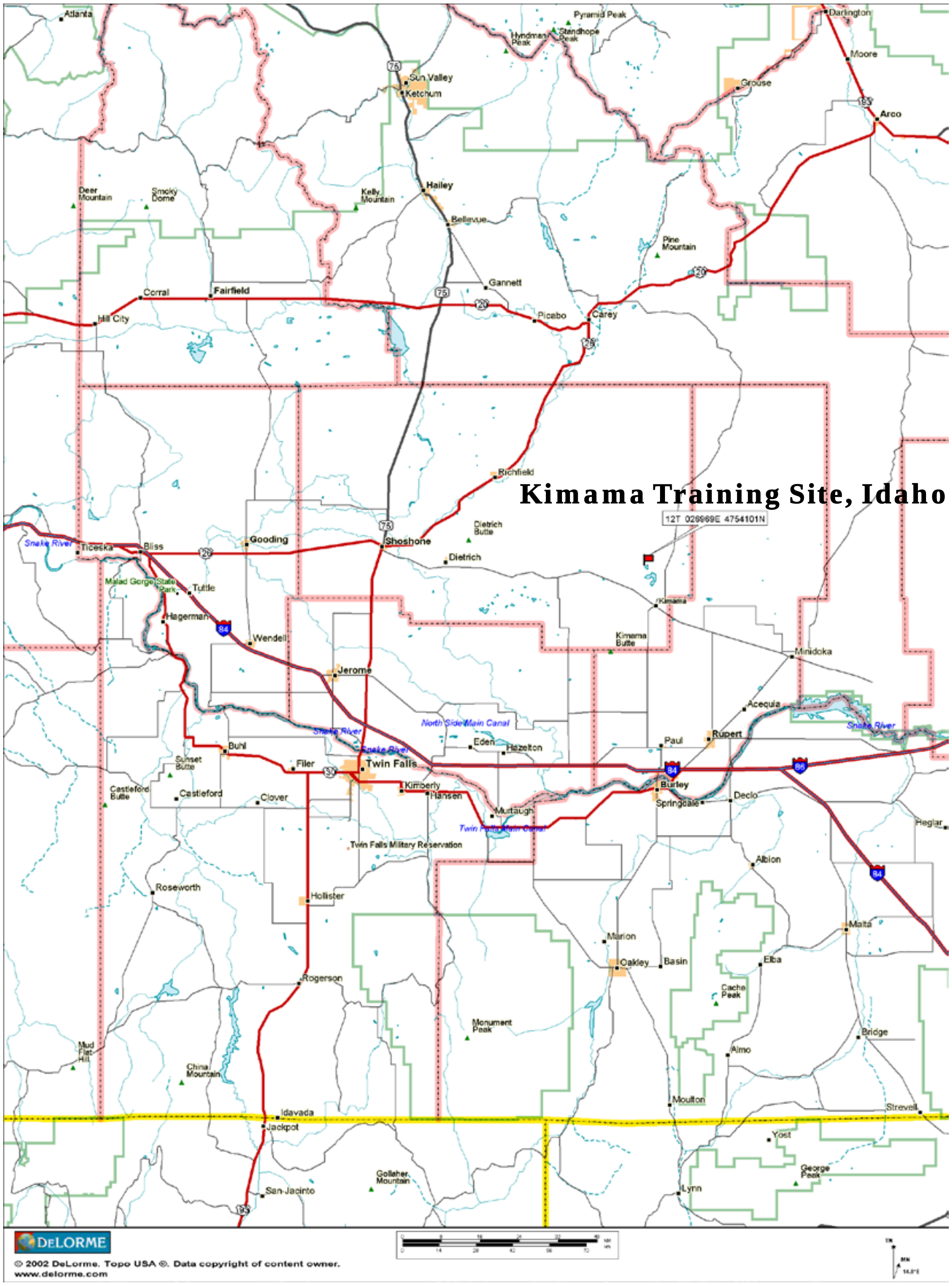


Figure 5. Location of Kimama Training Site, Idaho.

In 1992, the Idaho National Guard proposed to make modifications to the Kimama TS, including the construction of laser targets, live firing, and the use of 12 to 15 tracked vehicles (M1 tanks) during each training cycle. The

BLM did not sign the Idaho National Guard Memorandum of Understanding nor authorize modifying the existing permit (FPM 2009).

The Kimama TS was used for armored training and small arms with most of the intensive training occurring in concentrated areas. The area where we conducted the demonstration is referred to as Training Area 3, which encompasses approximately 14,322 acres (Fig. 6, 7, and 8). Training Area 3 was used for armored maneuver training from 1974 through 1993. Three small-arms ranges are located in the northwest portion of Training Area 3 and were used from 1969 through 1993. The three small-arms ranges encompass 2355 acres of Training Area 3.

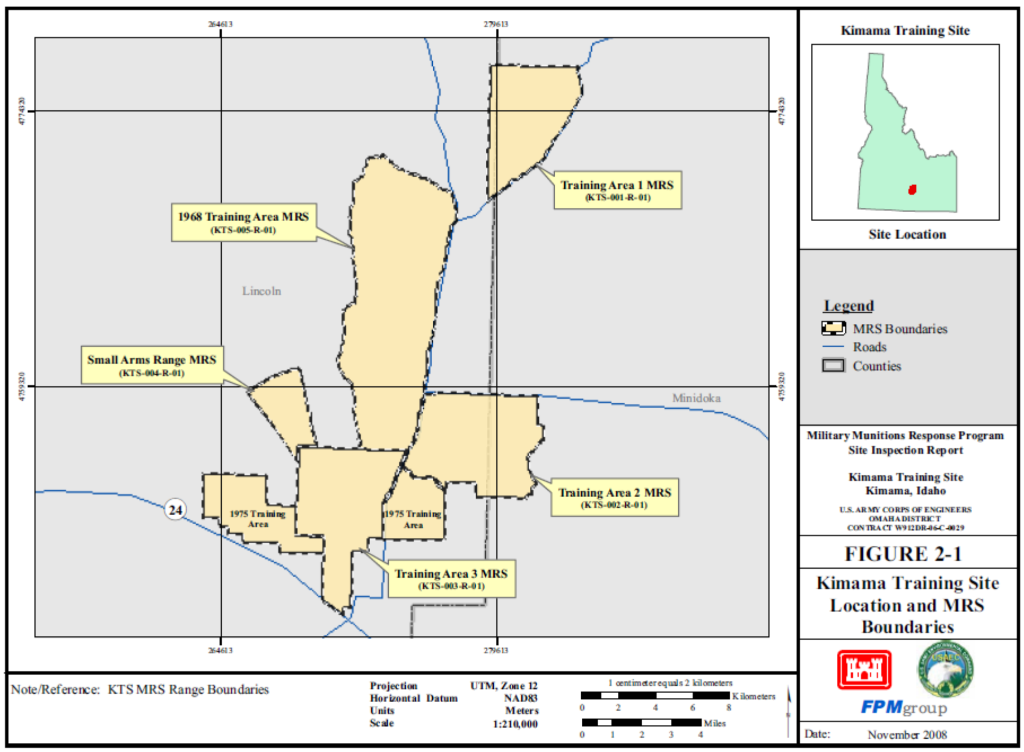


Figure 6. Map of Kimama Training Site and the location of Training Area 3 (FPM 2009).

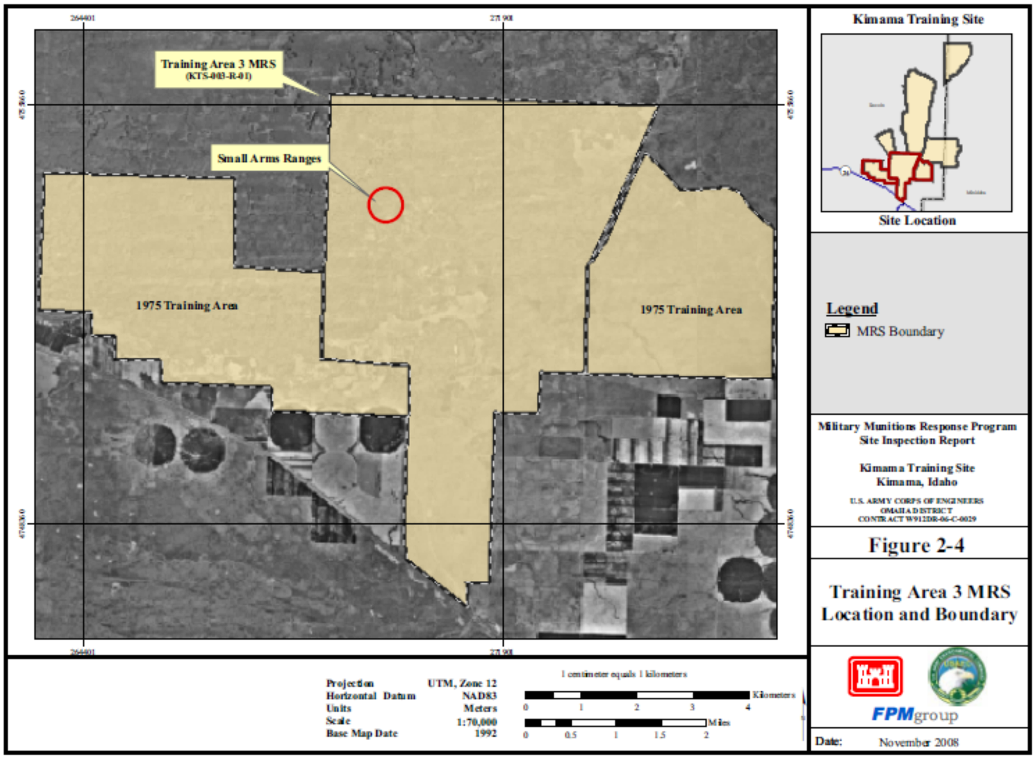


Figure 7. Location of the small-arms ranges on Training Area 3 (FPM 2009).

Figure 8. Location of the westernmost small-arms range berm and background Decision-Unit boundary sampled in Training Area 3 of the Kimama Training Site.

Munitions used at Training Area 3 included small arms, star clusters, riot control grenades, trip flares, practice mortar fuzes, 40-mm practice rifle grenades, and M69 practice hand grenades. The ordnance used on the small-arms ranges included 7.62 mm, .45 cal, .22 cal, and .50 cal. The munitions constituents (Pb and Sb) were detected at levels on the small-arms range during an SI (Fig. 9), warranting further investigation (FPM 2009).

A Remedial Investigation/Feasibility Study (RI/FS) project plan was prepared in October 2010 with the fieldwork anticipated to be complete by July 2011 (FPM 2010).

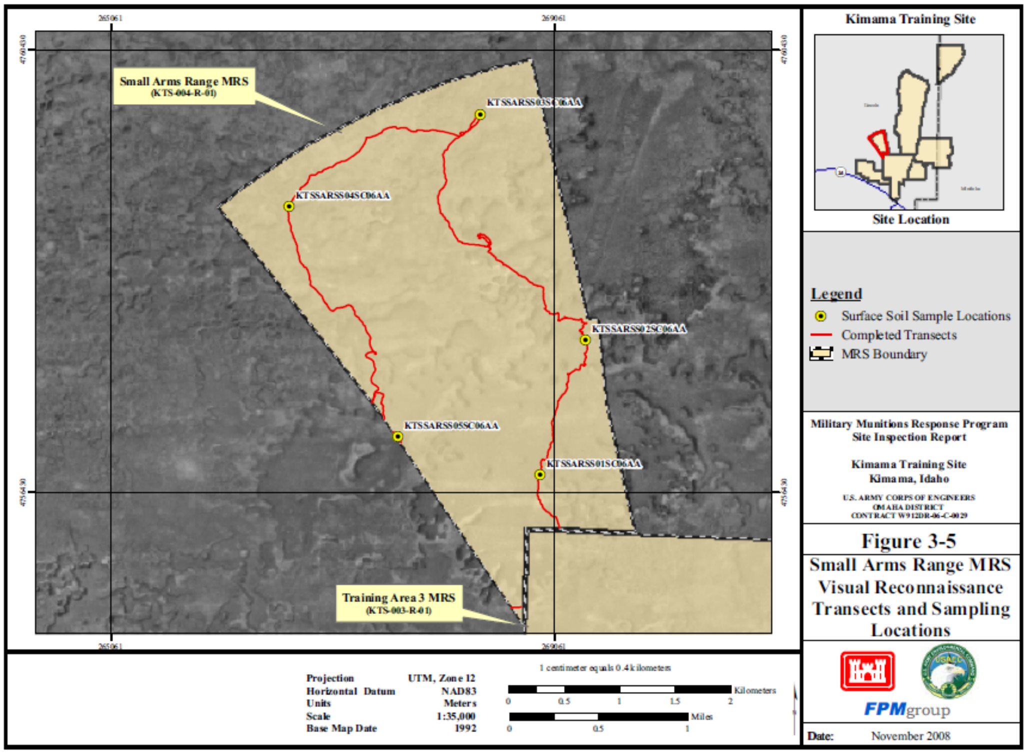


Figure 9. Location of the small-arms range sampling locations on Training Area 3 (FPM 2009).

4.1.2 Fort Eustis

The demonstration conducted at Fort Eustis, VA, occurred on the northern berm of the 1000-in. Rifle Range. Fort Eustis is located within the geographic boundaries of Newport News, VA, in the southeastern portion of the state (Fig. 10). Fort Eustis occupies approximately 8248 acres and is bounded by the James River to the west and south and the Warwick River to the east. Population estimates for Fort Eustis vary. Approximately 4510 military personnel and 4944 DoD civilian and contractors work at Fort Eustis. The cantonment area of Fort Eustis (approximately 2300 acres) is located in the northwest part of the installation.

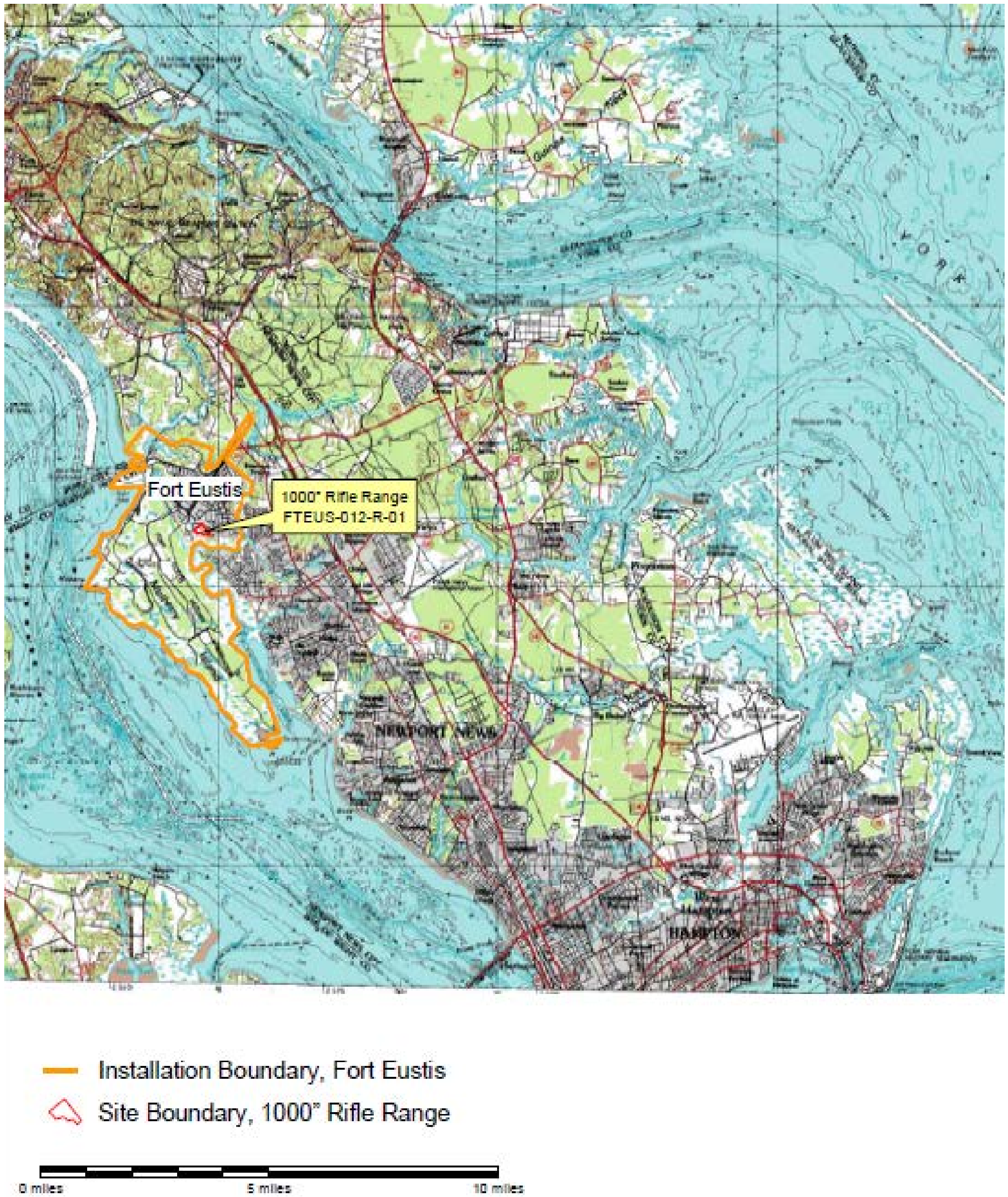


Figure 10. Map showing the location of Fort Eustis, VA.

The 1000-in. Rifle Range is located within the cantonment area of Fort Eustis and is a former small-arms training range used between 1920 and 1941 for target practice using 0.22-, 0.30-, and 0.45-caliber munitions (Fig. 11). The 1000-in. Rifle Range is estimated to cover 18.5 acres. A backstop berm remains near the center of the site. Most of the site is currently unmanaged woodlands (about 9.1 acres) or unwooded areas used for athletics, gardens, and other uses (about 7.6 acres). The 1000-in. Rifle Range

is divided into three adjacent sections consisting of known or possible firing ranges. The three sections were laid out with progressively shorter firing lanes going from 300 m (now termed the northern range), to 200 m (central range), to 100 m (southern range). The firing positions for all three ranges would have run in a line parallel to the eastern side of the site. The direction of fire for each range would have been to the west southwest. Earthen berms that were used as target backstops were located in the southwest side of each range. Two of the three berms remain. The central berm was destroyed with the construction of Landfill 7 though some of its soil appears to have been stockpiled nearby. A description of the northern berm, which was sampled, follows.

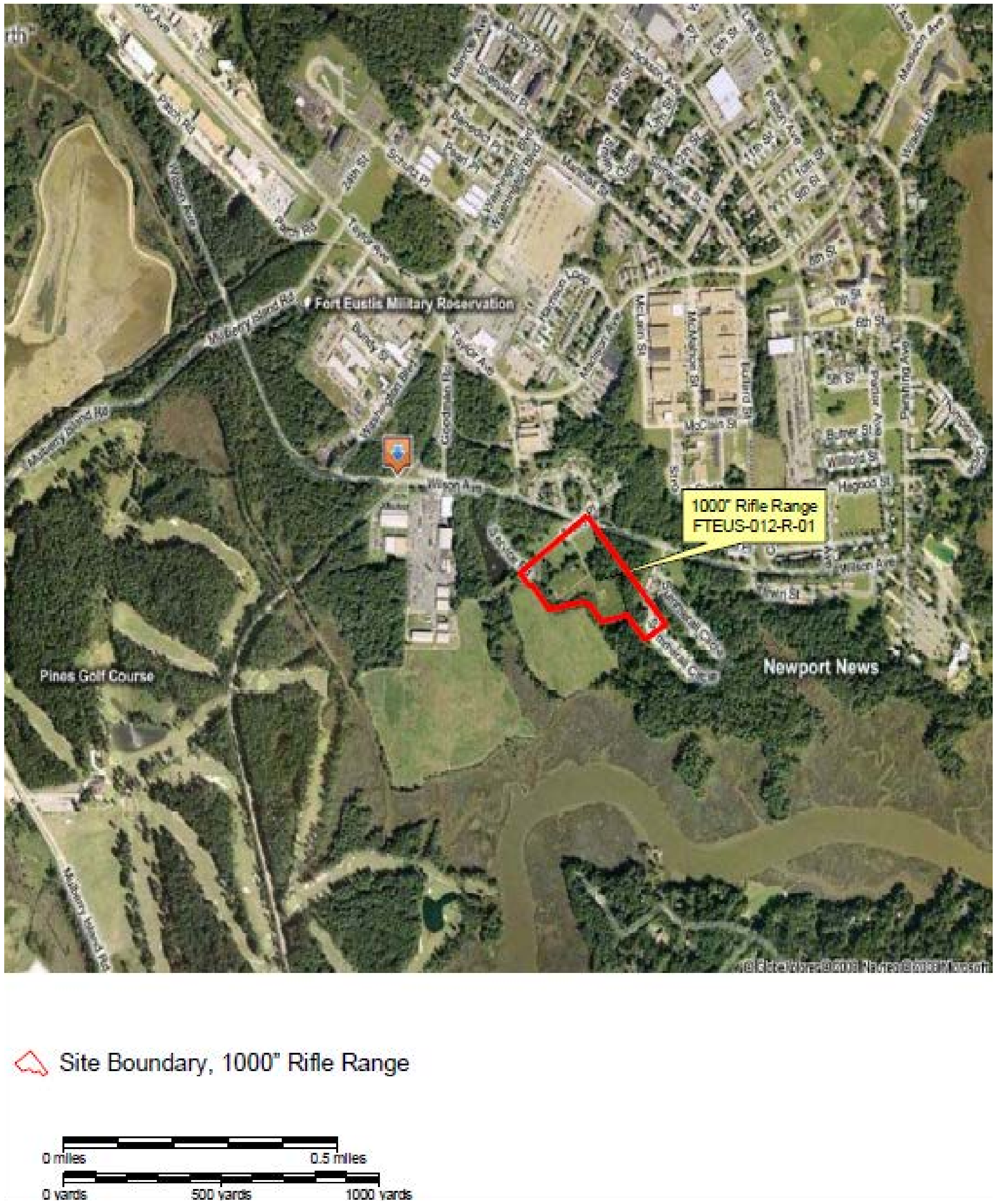


Figure 11. Location of the 1000-in. Rifle Range at Fort Eustis.

The northern range had a firing distance of up to 300 m though intermediate firing positions may also have been used. The berm, which runs perpendicular to the direction of fire, is approximately 140 m long and 15 m wide. The berm is backed by a concrete wall (on the west side) that has a maximum height of approximately 3 m (at its northern end) but tapers down to 1 m (at the southern end).

4.1.3 Fort Wainwright

Fort Wainwright is located in central Alaska near Fairbanks and covers approximately 910,498 acres (Fig. 12). The three major portions of the military installation include the cantonment area with most of the facility structures; the Yukon Maneuver Area, where most of the troop and aircraft exercises occur; and the Tanana Flats, where occasional aircraft training takes place, including a portion north of Tanana River,.

Figure 12. Map of Fort Wainwright, Alaska.

Fort Wainwright, AK, was established in 1935 and was originally named Ladd Field in honor of Major Arthur Ladd, an Air Corps pilot killed in a crash in 1935. The first Air Corps detachment assigned to Alaska arrived in Fairbanks in April 1940. During World War II, Ladd Field took on a large role, that of transfer point for the Lend Lease Program, in which the US delivered nearly 8000 aircraft to Russia. The Army assumed control of Ladd Air Force Base in January 1961 and renamed it Fort Jonathan M. Wainwright, honoring the World War II general who led delaying tactics on Bataan and Corregidor in the Philippines against a superior Japanese force. Since 1961, the post has been home to the 171st Infantry Brigade; the 172nd Infantry Brigade; the 6th Infantry Division (Light); the 1st Brigade; the 172nd Stryker Brigade Combat Team; and presently the 1st Stryker Brigade Combat Team, 25th Infantry Division. The post is also home to Task

Force 49, a brigade-size aviation unit with CH-47 Chinooks, UH-60 Black Hawks, and OH-58 Kiowas as well as support personnel. Presently, there are roughly 7700 soldiers assigned to the post with all types of training supported. The demonstration was conducted on the Range 16 Records Range of the Fort Wainwright Small Arms Range Complex located off of (south) Richardson Highway (Fig. 13).

Figure 13. Aerial photograph of Range 16 Record Range at Fort Wainwright, Alaska.

4.2 Site geology and hydrogeology

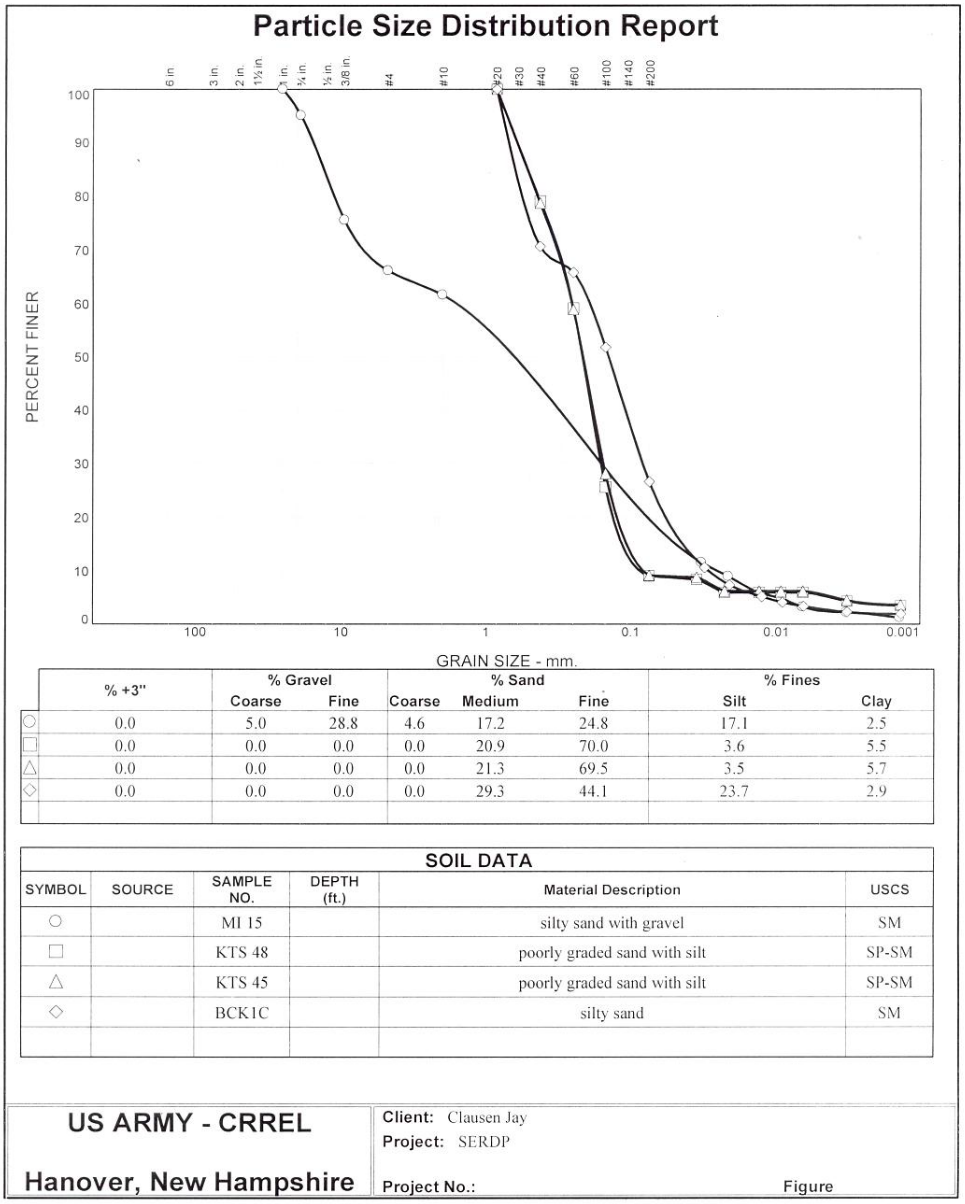
4.2.1 Kimama Training Site

The Kimama TS is located at an elevation of approximately 1280 m above sea level and is located in a sagebrush steppe environment characterized by a semi-arid climate with dry summers. The average annual precipitation is approximately 23 cm. The average daily temperature during the summer is 22°C with high temperatures reaching 32°C. The average daily temperature during the winter is −3°C with an average low temperature of −8°C.

The site is located in the Snake River Plain, a topographic depression extending across the entire southern portion of the state of Idaho. The surface lithology largely consists of volcanic deposits laid down during the Pleistocene and Holocene period. Surficial deposits include approximately 3- to 15-m-thick sections of interbedded lacustrine and fluvial sediments (Idaho Geological Survey 2011). The site is almost entirely underlain by fractured Quaternary Snake River Basalt of the Snake River Group. Its lithology consists of mafic volcanic flows, rhyolite, and unconsolidated sediments. Basalt flows typically range in thickness from 5 to 25 m. Interbeds between the basalt layers are mainly sand, silt, and clay with smaller amounts of volcanic ash.

Soils are volcanic in character and consist mainly of silt loam with some small areas of sandy loam. Our analysis of two samples (KTS45 and KTS48) yielded a determination of poorly graded sand with silt (Fig. 14). Some aeolian soil erosion has occurred in the vicinity of previous tank activity, particularly in the sandier soils (USACE 1972).

The Kimama TS overlies the Snake River Aquifer, which occurs in basalt and sediments of the Snake River Group. The aquifer is located at an estimated depth of 100–150 m below ground surface. Groundwater flows most rapidly in the upper 60 m, which is the most productive portion of the aquifer and is associated with permeable zones consisting of the tops and bottoms of the basalt lava flows (USACE 1972). Columnar jointing within a lava flow provides slow vertical transmission of water. The total thickness of the basalt lava flows is estimated to be more than 1500 m. Rhyolite underlies the basalt flows and has a low permeability because many of the pore spaces are filled with chemical precipitates. Unconsolidated sediments beneath the Snake River Plain contain a high percentage of inter-granular pore spaces, which are permeable yet are resistive to flow. The Snake River Aquifer tends to have low hardness and dissolved mineral content because of its unique mineralogy and its very high ground water flow rate. Groundwater recharge comes primarily from downward percolation of precipitation and snowmelt, underflow from tributary basins, leakage from streams entering or crossing the Snake River plain, and infiltration of surface water diverted for irrigation.



	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0.0	5.0	28.8	4.6	17.2	24.8	17.1	2.5
□	0.0	0.0	0.0	0.0	20.9	70.0	3.6	5.5
△	0.0	0.0	0.0	0.0	21.3	69.5	3.5	5.7
◇	0.0	0.0	0.0	0.0	29.3	44.1	23.7	2.9

SOIL DATA

SYMBOL	SOURCE	SAMPLE NO.	DEPTH (ft.)	Material Description	USCS
○		MI 15		silty sand with gravel	SM
□		KTS 48		poorly graded sand with silt	SP-SM
△		KTS 45		poorly graded sand with silt	SP-SM
◇		BCK1C		silty sand	SM

US ARMY - CRREL

Hanover, New Hampshire

Client: Clausen Jay
Project: SERDP
Project No.: Figure

Figure 14. Particle size for soil samples collected from Kimama Training Site, Fort Eustis, and Fort Wainwright.

4.2.2 Fort Eustis

Fort Eustis lies within the Atlantic Coastal Plan and consists of unconsolidated and interbedded sands and clays with minor amounts of gravel and shell fragments. Locally, the site geology consists of impermeable clays, silts, and clayey sand with sand and silty sand lenses. Previous grain size analysis of soils in the 1000-in. Range were characterized as silty sand (URS 2010), which is consistent with the particle size for a sample

(BCK1C) collected during this study (Fig. 14). Groundwater, which flows toward the Warwick River, is present at depths of 4 to 6 m below ground surface (URS 2010). The 1000-in. Rifle Range drains through marshes into the Warwick River.

4.2.3 Fort Wainwright

The climate at Fort Wainwright consists of extreme annual temperature variations, low precipitation, and light surface winds. According to NOAA records, the average annual temperature is −3.5°C with extremes ranging from −51° to 38°C. The average annual precipitation is 28 cm, and annual snowfall averages 178 cm.

The Fort Wainwright geology consists of Precambrian micaceous schist of the Birch Creek formation and includes metamorphic, sedimentary, and volcanic rocks of Paleozoic age (Péwé et al. 1966). Upland areas adjacent to the Tanana River usually are covered with Pleistocene loess deposits varying from a few centimeters on hilltops to over 60 m in low-lying areas and upland areas adjacent to the Tanana River (Jorgenson et al. 1999). Some loess has been transported from the hills to the valley floors where it forms laminar to massive silt-rich deposits of organic debris (Péwé 1975). Fluvial sediments of the Tanana River occupy a large portion of the installation (Collins 1990; Mason and Beget 1991; Mann et al. 1995).

Soils of the study area tend to be poorly developed Inceptisols, undeveloped Entisols, or Histosols (Rieger et al. 1963, 1979; Swanson and Mungoven 1998). Jorgenson et al. (1999) further describe the soil:

> Ochrepts (well-drained Inceptisols that have only small amounts of organic matter at the surface) occur on hills where permafrost generally is absent. Aquepts (wet Inceptisols with thin to thick layers of poorly decomposed organic matter) occur in poorly drained areas and are commonly associated with ice-rich permafrost. Aquents or Fluvents (wet mineral Entisols associated with shallow or deep water tables) occur on floodplains and seepage areas. Histol soils, such as Fibrists (deep organic soils composed mostly of undecomposed sedges or mosses), occur in depressions

or wet areas that undergo long periods of soil saturation. Permafrost may or may not be present in these organic soils.

Overall, permafrost tends to occur on north facing slopes and valley bottoms and is absent on south-facing slopes, coarse-grained sediments, and areas of groundwater movement (Viereck et al. 1984; Williams 1970).

The Fort Wainwright Small Arms Complex is located on the floodplain of the Tanana River, between the Richardson Highway and the Tanana River Flood Control Levee running along the right (north) bank of the Tanana River. The Small Arms Complex is located on surficial deposits mapped as the "Chena Alluvium" by Péwé et al. (1976). This consists of well-stratified layers and lenses of unconsolidated sand and rounded river gravel overlain by as much as 5 m of silt, Late Pleistocene to Holocene in age. Gravel consists mostly of quartz and metamorphic rock with clasts ranging from 0.3 to 7.5 cm in diameter. The gravel unit is from 3 to more than 130 m thick. It is locally perennially frozen down to 85 m with low ice content. In addition, there are discontinuous swales and slough deposits consisting of poorly stratified lenses and layers of stream-laid silt and silty sand. The gravel unit is fairly well sorted and can contain up to 30% clay. These swale and slough deposits are locally perennially frozen with moderate to high ice content. Analysis of a surface soil from the study area (sample MI 15) yielded a particle distribution consistent with a silty sand with gravel (Fig. 14).

4.3 Contaminant distribution

4.3.1 Kimama Training Site

During SI, the munitions constituents Pb and Sb were detected at levels warranting further investigation (FPM 2009). The samples collected were grab samples. A subsequent RI and Feasibility Study of the small-arms range at Training Area 3 yielded no metal results exceeding USEPA screening criteria (Table 6). However, only five random composite samples were collected consisting of seven increments each from a radius of 0.3 m (Fig. 9). The composite sampling locations were selected at random with none of the samples collected from the berm face, presumably where one would expect to find the highest metal concentrations.

Table 6. Previous metal sampling results from Kimama Training Site.

Sample ID	Screening Levels[1]	EPA Soil Screening Level[2]	KTSSARSS 01SC06AA	KTSSARSS 02SC06AA	KTSSARSS 03SC06AA	KTSSARSS 04SC06AA	KTSSARSS 05SC06AA
Date of Collection			6/5/08	6/5/08	6/5/08	6/5/08	6/5/08
Metals mg/kg							
Lead	49.6	400	11.3	14.0	12.5	9.0	10.2

Notes:

mg/kg = milligram per kilogram.

[1] = Idaho Initial Default Target Levels (IDTL) based on groundwater protection.

[2] = The Screening Levels are the September 2008 EPA Region IX Residential Soil PRGs.

4.3.2 Fort Eustis

The site is managed under the MMRP and has recently undergone an SI completed in 2007. The SI involved the collection of 24 shallow soil samples taken at depths of 0 to 27 cm in the berms and firing lanes of the 1000-in. Rifle Range and analyzed for lead (Table 7). All but four of these samples indicated lead concentrations higher than the basewide background level (23 mg/kg). Three of the soil samples had lead concentrations higher than the recommended soil screening level for residential use (400 mg/kg)—two in the Northern Berm and one in the Central Berm remnant (Fig. 15).

4.3.3 Fort Wainwright

The small-arms ranges at Fort Wainwright have not previously been sampled and analyzed for metals, principally since these are active ranges. Given the use of projectiles containing Sb, Cu, Pb, and Zn, the presumption was that these metals were likely present above background levels.

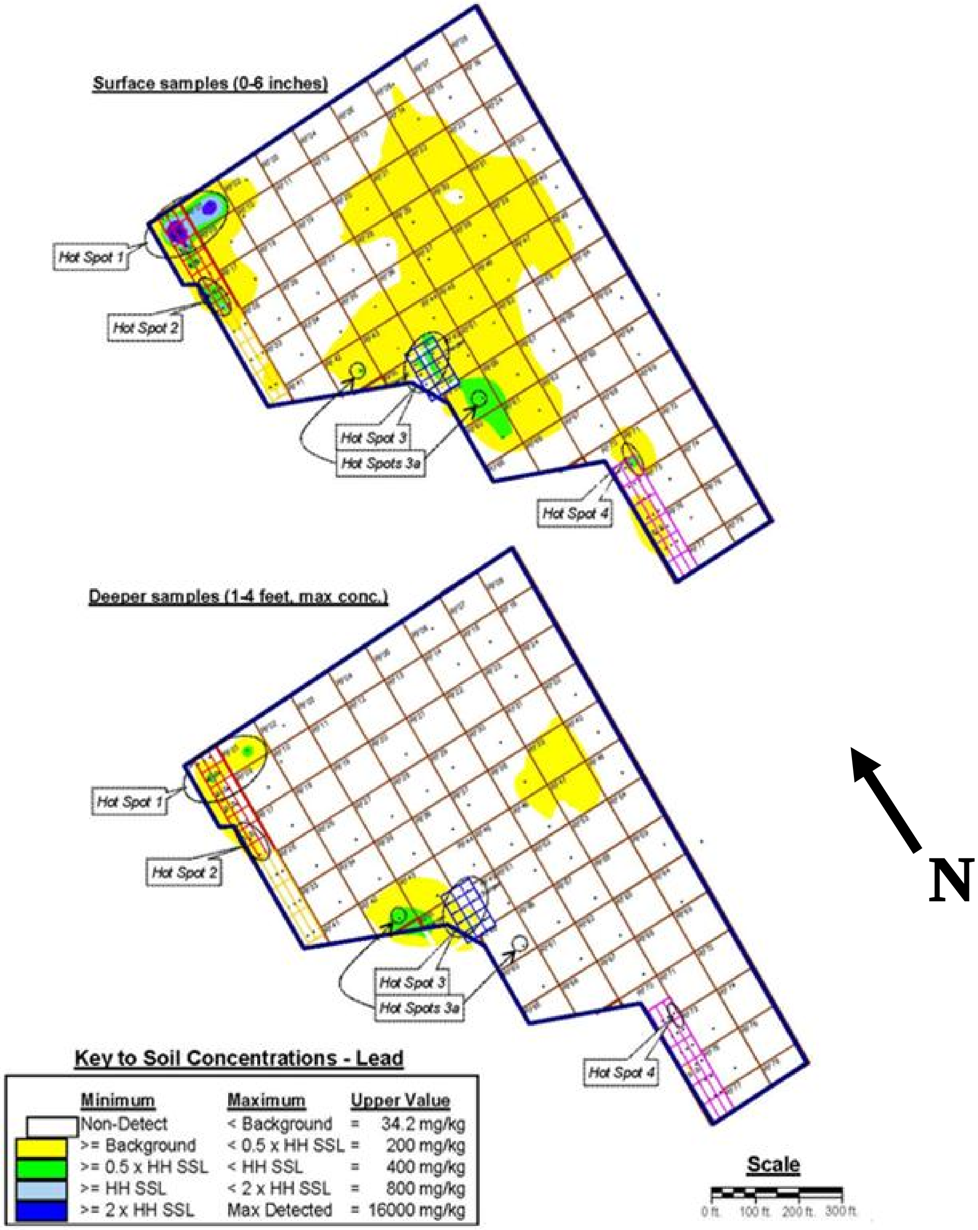


Figure 15. Lead concentrations (mg/kg) in surface soil at the 1000-in. Range at Fort Eustis (modified from URS 2010).

Table 7. Previous metal sampling results from the 1000-in. Rifle Range at Fort Eustis.

Location/ Sample ID	Result (mg/kg)	Note	Location/ Sample ID	Result (mg/kg)	Note
Northern Berm			Southern Berm		
FE1SSD01	290		FE1SSD13	14.7	
FE1SSD02	390		FE1SSD14	39.3	
FE1SSD03	**404**		FE1SSD15	40.5	
FE1SSD04	189		FE1SSC18	81.7	
FE1SSD04D	158	Duplicate	FE1SSC18D	97.3	Duplicate
FE1SSD05	9.6		FE1SSC19	38	
FE1SSC06	**3,790**		FE1SSC20	15.4	
FE1SSC07	99.3		FE1SSD13	14.7	
FE1SSC09	66.7		FE1SSD14	39.3	
Central Berm Remnant			Range Floor		
FE1SSD11	193		FE1SSC08	125	
FE1SSD12	128		FE1SSC10	23.9	
FE1SSC16	**403**		FE1SSD21	18.4	
FE1SSC17	366		FE1SSD22	59.1	
			FE1SSC23	32.7	
			FE1SSC24	52.6	

Notes:
(1) Concentrations are presented in mg/kg
(2) Background levels for lead is 23 mg/kg
(3) Residential SSL for lead is 400 mg/kg
(4) Bold: Exceeds Residential SSL

SSL: Soil Screening Level
Sixth digit in Sample ID
C composite sample
D discrete sample

5 Test Design

5.1 Conceptual experimental design

The experimental design for the demonstration was generally the same for all three sites. We considered the entire impact berm face for each site the DU (Fig. 16). Both the Kimama TS and Fort Eustis sites had a single intact berm (Fig. 17 and 18). In contrast, the range at Fort Wainwright consisted of multiple (16) individual berms located at varying distances downrange from an individual firing point (Fig. 19). At Fort Wainwright, we collected samples from all 16 berms at the 100-m downrange distance from the firing point to form the DU (Fig. 20). In the case of Fort Wainwright, we also designated the firing point a DU and sampled using ISM to demonstrate that the methodology developed for metals was equally applicable to energetics (i.e., a single sample could be collected for both analyses). The firing points at Kimama TS and Fort Eustis were no longer identifiable; therefore, we did not collect samples.

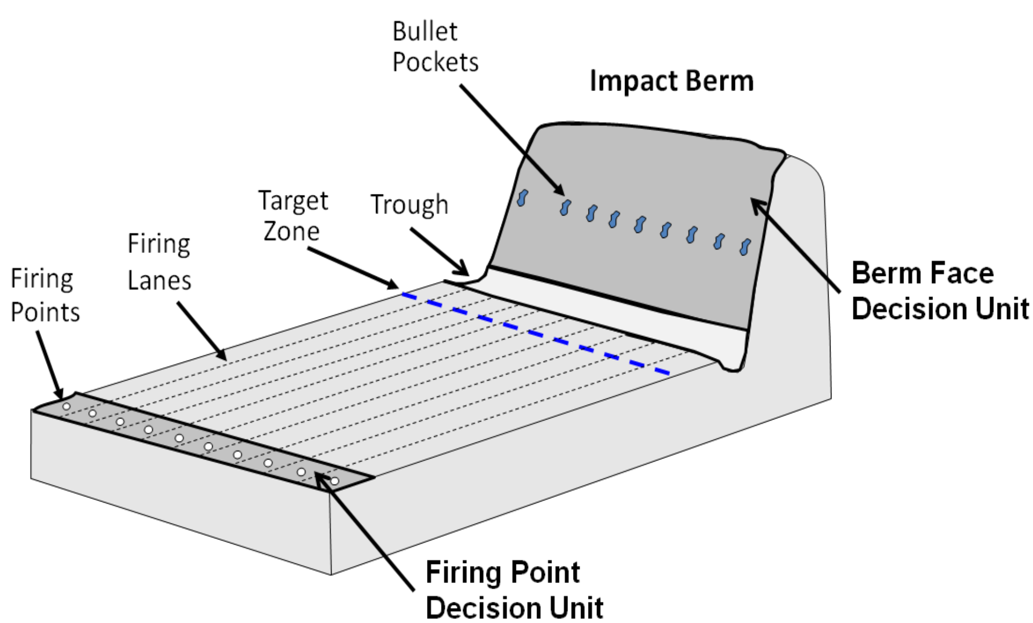


Figure 16. Generic example of a typical small-arms firing range.

Figure 17. The northernmost small-arms range berm face located in Training Area 3 of Kimama TS.

Figure 18. The northern end of the1000-in. small-arms range berm face at Fort Eustis.

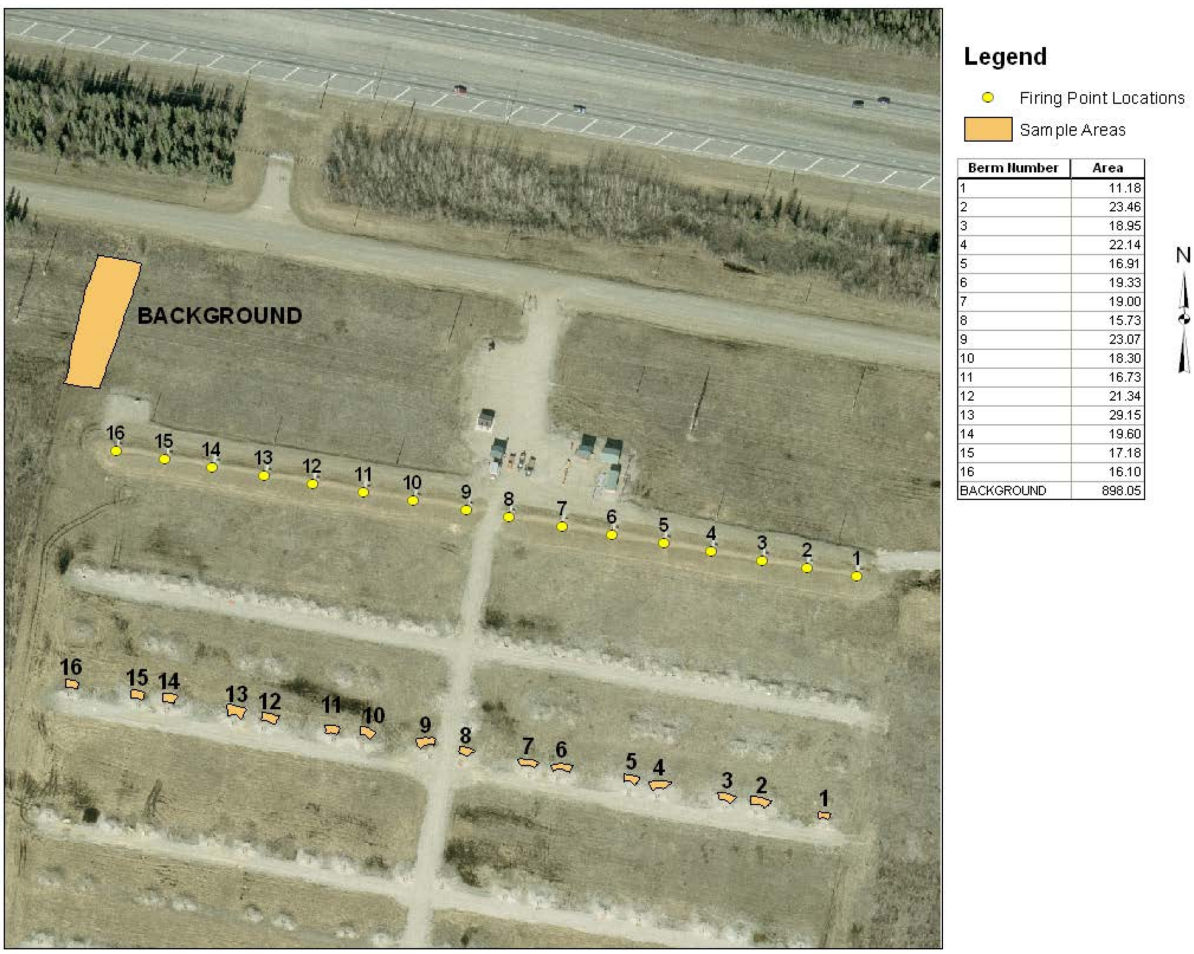
Figure 19. The small-arms firing Range 16 Record berms at Fort Wainwright.

Using the random systematic approach (Fig. 2), the team collected 15 replicate ISM samples from both the berm face DU and the firing point DU at Fort Wainwright to yield 30 individual samples (Fig. 20). At the Kimama TS and at Fort Eustis, only 15 replicate ISM samples were collected from the berm face DUs at each installation as the firing points could not be identified. Each replicate ISM sample consisted of approximately 100 increments.

In the case of the berms at Fort Wainwright, we collected six increments from each of the 16 berms and combined them to yield a “collective” berm sample (Fig. 19). In addition, we subdivided the berms into 3 SUs with samples pooled from the upper left, upper right, and lower bottom to look at the distribution of metal within the berm. Finally, we subdivided Berm 11 into two SUs (left and right) to determine whether the results for the right and left sides of the berm were similar.

The berm at Fort Eustis was a single DU that we divided into three SUs. Previous sampling (URS 2007) indicated an area of elevated metal content on the northern end of the berm (Fig. 13).

In addition to the ISM samples for each site, within each berm face DU we created a grid and collected individual grab samples for all three sites (Fig. 20, 21, and 22). Figures 22 and 23 show the DU defined at Fort Eustis and the grab sampling pattern. For each of the 16 individual berms at Fort Wainwright, the team collected three discrete samples using the pattern shown in Figure 24.



Berm Number	Area
1	11.18
2	23.46
3	18.95
4	22.14
5	16.91
6	19.33
7	19.00
8	15.73
9	23.07
10	18.30
11	16.73
12	21.34
13	29.15
14	19.60
15	17.18
16	16.10
BACKGROUND	898.05

Figure 20. Location of berms sampled using ISM and grab techniques at the Range 16 Record Range at Fort Wainwright.

1	2	3	4	5	6	7	8	9	10
11	12	13	14	15	16	17	18	19	20
21	22	23	24	25	26	27	28	29	30

Figure 21. Grab sample grid layout for Kimama TS berm face.

11	1	9	8	7	6	5	4	3	2	1
22	21	20	19	18	17	16	15	14	13	12
33	32	31	30	29	28	27	26	25	24	23

Figure 22. Grab sample grid layout for Fort Eustis berm face.

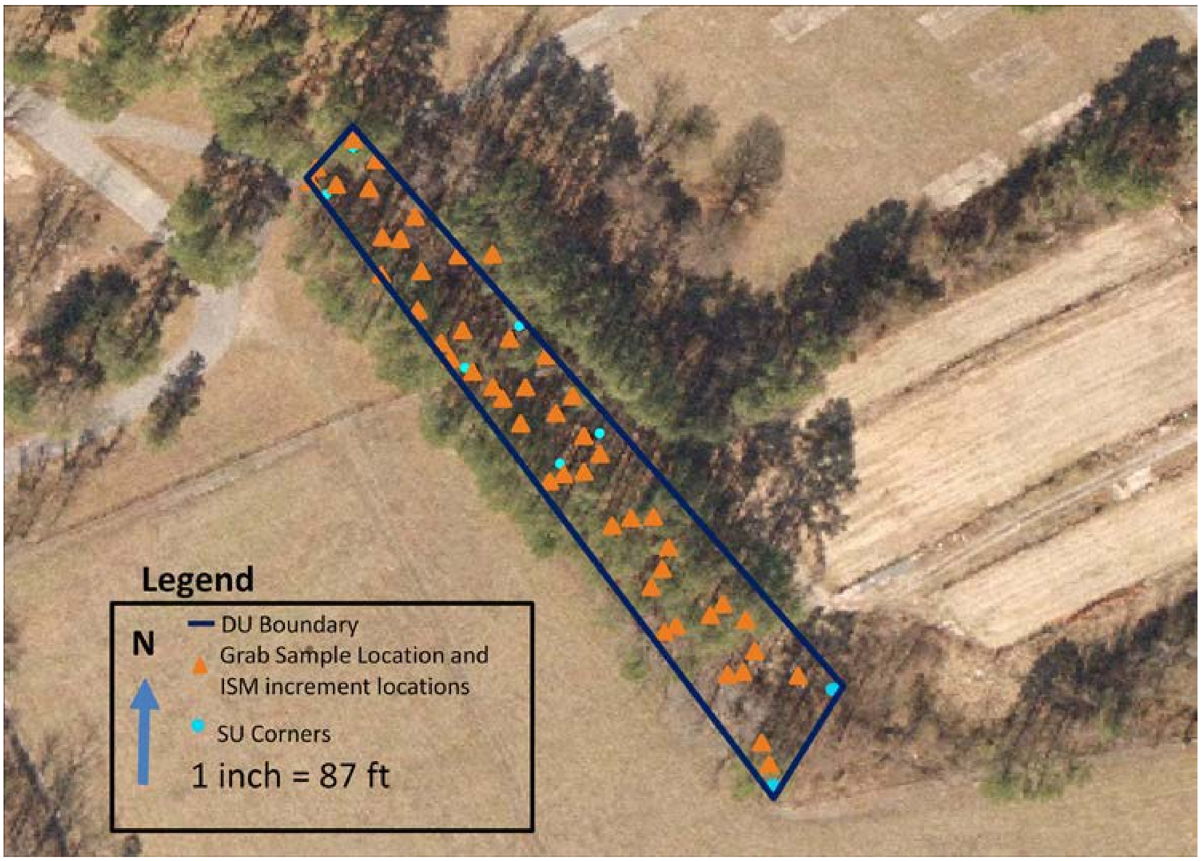


Figure 23. Arial view of grab sample grid locations (orange triangles) and DU boundaries (blue circles) for the 1000-in. Range berm face at Fort Eustis.

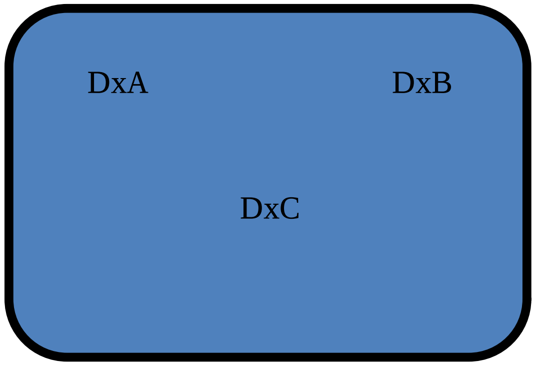


Figure 24. Grab sample grid layout for Fort Wainwright for an individual berm.

5.2 Baseline characterization

We collected background surface soil samples at Kimama TS (Fig. 7) and at Fort Wainwright (Fig. 19) and analyzed them for metals for comparison with samples obtained from the berm face and firing point DUs (Tables 8 and 9). We did not collect a background sample from Fort Eustis because there did not appear to be any undisturbed soil locations in the vicinity of the range. The concentration of Sb and thorium (Th) in the background sample from the Kimama TS was below the detection limit. At Fort Wainwright, silver (Ag), beryllium (Be), cadmium (Cd), Sb, and Th in the background sample were below the detection limit.

In addition to the metal content of the background samples, we determined several additional physical and chemical characteristics for the native soils, including grain size, total organic carbon (TOC), cation exchange capacity (CEC), and soil pH (Table 10).

5.3 Treatability or laboratory study results

The results from earlier laboratory studies under Task 1 of this project were presented in Section 2.2 *Technology Development* of Clausen et al. (2012b). No new treatability or laboratory studies were conducted for this demonstration.

Table 8. Summary of background metal concentrations for surface soil at the Kimama Training Site.

Background ISM	Mass (g)	Ag (mg/kg)	Al (mg/kg)	As (mg/kg)	Ba (mg/kg)	Be (mg/kg)	Ca (mg/kg)	Cd (mg/kg)	Co (mg/kg)	Cr (mg/kg)	Cu (mg/kg)	Fe (mg/kg)	K (mg/kg)	Mg (mg/kg)	Mn (mg/kg)	Na (mg/kg)	Ni (mg/kg)	P (mg/kg)	Pb (mg/kg)	Se (mg/kg)
n	3	2	3	1	3	1	3	1	3	3	3	3	3	3	3	3	3	3	3	1
Mean	1639	1512	5333	2.99	67.6	0.232	1653	1.34	3.42	131	7.96	8310	1360	1653	145	151	8.66	402	7.61	3.70
Median	1659	1526	4180	2.99	52.8	0.232	1300	1.34	2.74	123	5.71	6500	1100	1270	112	121	6.8	325	5.57	3.70
Min	1480	1364	3960	2.99	52.0	0.232	1290	1.34	2.65	112	5.67	6430	1000	1240	111	121	6.79	315	5.17	3.70
Max	1778	1645	7860	2.99	98.0	0.232	2370	1.34	4.87	159	12.5	12000	1980	2450	211	211	12.4	566	12.1	3.70
STD	150	NA	2191	NA	26.3	NA	621	NA	1.26	24.6	3.93	3196	539	690	57.4	52.0	3.24	142	3.89	NA
RSD	9	NA	41	NA	39	NA	38	NA	37	19	49	38	40	42	40	34	37	35	51	NA

Table 9. Summary of background metal concentrations for surface soil near the Range 16 Record Range at Fort Wainwright.

Grab Background	Mass (g)	Al (mg/kg)	As (mg/kg)	Ba (mg/kg)	Ca (mg/kg)	Co (mg/kg)	Cr (mg/kg)	Cu (mg/kg)	Fe (mg/kg)	K (mg/kg)	Mg (mg/kg)	Mn (mg/kg)	Na (mg/kg)	Ni (mg/kg)	P (mg/kg)	Pb (mg/kg)	Se (mg/kg)	Silica (mg/kg)
n	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	1	4
Mean	63.4	10755	11.4	141	8145	10.6	21.6	26.8	20725	1468	5910	467	477	21.9	549	63.7	2.20	69.5
Median	63.2	10340	11.8	141	8160	10.2	20.4	24.5	20050	1225	5475	446	427	20.3	548	55.4	2.20	44.1
Min	49.4	8340	7.97	120	6380	8.82	16.7	21.2	16500	1010	4950	418	361	17.7	503	8.08	2.20	36.8
Max	77.7	14000	14.1	162	9880	13.3	28.8	36.9	26300	2410	7740	556	694	29.4	598	136	2.20	153
STDEV	16.1	2543	2.97	17.2	1454	2.09	5.58	7.10	4820	637	1262	63.5	148	5.34	45.0	62.8	NA	55.9
RSD (%)	25	24	26	12	18	20	26	27	23	43	21	14	31	24	8	99	NA	80

Table 10. Summary of physical and chemical properties of the different background samples.

Field Sample ID	Site	Analysis Date	Cation Exchange Capacity (meq/g)	Organic Matter (% by weight)	Total Organic Carbon (mg/kg)	pH	Soil Type
Bck1C	Fort Wainwright	30-Apr-12	0.769	25.3	165000	6.23	Silty sand
FTWWMI-15	Fort Eustis	30-Apr-12	0.205	1.8	8740	6.91	Silty sand w/gravel
KTS-45	Kimama TS	30-Apr-12	0.154	2.1	8980	6.49	Poorly graded sand w/silt
KTS-48	Kimama TS	30-Apr-12	0.171	3.8	25000	5.56	Poorly graded sand w/silt

5.4 Design and layout of technology components

Each ISM sample involved collecting approximately 100 increments within a DU using systematic random sampling (Fig. 2). A DU was established at both the firing point and berm face of the Fort Wainwright small-arms range and at the berm faces at both Fort Eustis and Kimama TS (Fig. 19–23). The firing points for the Fort Eustis and Kimama TS could not be located. The firing point DU at Fort Wainwright extended 5 m behind and 5 min in front of the firing point and encompassed all firing lanes at the small-arms range. The berm face DU encompassed an area including all firing lanes and from the base of the berm face to the top. At Fort Wainwright, a continuous berm is not present so the test considered the 16 individual berms located at 100 m down range from the firing point a contiguous berm. The area sampled represented approximately 0.5 acres.

Within each DU, we collected approximately 100 evenly spaced increments to form an individual ISM surface soil sample. We collected the ISM samples using CMIST (Walsh 2009) (Fig 3). The CMIST extracted cylindrical soil cores referred to as “increments.” The coring bit used had a diameter of 2 cm. The sampling depth used at all 3 sites was 5 cm, which yielded an ISM sample of approximately 1–2 kg. We sampled seven replicate samples of the northern portion of the berm at Fort Eustis using a 3-cm diameter core as well.

The required mass is a function of the soil volume of each core (the sampling depth and core diameter), the number of cores or increments collected, and the mean soil density. For example, if the mean soil density is 1.6 g/cm and the coring depth is 5 cm, a 2-cm core will result in an ISM sample with a mass of 1–2 kg. The mass of the ISM sample for the three sites varied from 0.5 to 2.5 kg. Although, the typical approach is to collect three replicate ISM samples for each DU, to assess uncertainty for this demonstration, we collected 15 replicate samples to facilitate statistical analysis of the data.

Using a grid-node approach, the team collected 48 grab samples from Fort Wainwright, 33 from Fort Eustis (Fig. 20), and 30 from Kimama TS (Fig. 21). From within each node, we collected a single increment, using the CMIST sampler, and placed it in an individual 4-oz amber container, yielding a sample mass of approximately 0.2 kg. Typically, grab samples

would be collected with a metal scoop. However, for direct comparison between the ISM and grab samples, we needed the same sample device. For a typical small-arms range, one would typically obtain a half-dozen to a dozen grab samples. However, to facilitate statistical analysis of the data and the comparisons with the ISM data, we collected more samples than is typical. The grid-node layout encompassed the same area as the DUs where we collected the ISM samples.

5.5 Field testing

There are basically four field phases to ISM: (1) Project Planning, (2) Mobilization, (3) Surveying/Sampling, and (4) Demobilization (Table 11). The Project Planning phase involves developing the conceptual site model, determining the study objectives, identifying the data needs, establishing the DU, and defining the depth and number of increments per ISM sample. Mobilization involves gathering the field equipment together and traveling to the site. The third phase involves demarcating the DU in the field, surveying the DU boundary or a corner of the DU, and sampling. The first three steps are identical to current conventional sampling with the exception of ISM. Sampling involved collecting conventional grab samples from within the DU and collecting ISM samples. Demobilization involved packing up the sampling equipment, shipping samples back to the laboratory, and traveling. Again, this is no different than the current conventional methods. No investigative derived waste was created nor was equipment left at the sites.

Table 11. Gantt chart for field demonstration activities.

	September 2011			October 2011				November 2011				December 2011				
Activity	12-16	19-22	26-30	3-7	11-14	17-21	24-28	31-4	6-10	14-18	21-23	28-2	5-9	12-16	19-23	27-30
Fort Wainwright																
Project Planning																
Mobilization																
Surveying/Sampling																
Demobilization																
Kimama Training Site																
Project Planning																
Mobilization																
Surveying/Sampling																
Demobilization																
Fort Eustis																
Project Planning																
Mobilization																
Surveying/Sampling																
Demobilization																

5.6 Sampling methods

The team collected conventional grab and ISM samples from three small-arms range berm DUs at three different military sites. We collected one firing point DU sample at Fort Wainwright to assess the suitability of collecting and processing a single sample for both metal and energetic analysis. We determined a boundary for each DU in the field based largely on the observable extent of the impact berm or firing point. We followed the conventional grid node approach when collecting grab surface soil samples (Fig. 20, 21, and 23) from within each DU and individually surveyed all grab sample locations. Instead of using a metal scoop, we used the CMIST to collect the grab sample from the center of the grid. The 2-cm diameter corer collected a 5-cm-deep sample. We processed the grab samples following the USEPA Method 5030B, which basically involved scooping a 1-g sample out from the top of the sample jar and then performing the standard digestion. Method 3050B does not mandate sieving soil samples or have specific requirements for homogenization or sample-processing procedures (e.g., subsampling); thus, conventional grab sample preparation may vary between commercial testing laboratories. Metals analysis followed USEPA Method 6010 (Table 12).

Table 12. Comparison of Grab versus ISM for this demonstration.

Activity	Conventional Grab Sampling	Incremental Sampling Method
Surveying	Each individual sample location was flagged and surveyed.	The DU corners were determined and demarcated with flagging as were lane boundaries for sample collection. The four corners of the DU were surveyed.
Soil Sampling	Not explicitly addressed in Method 3050B. Grab samples collected with CMIST from biased locations. Typically, about 200 g of soil was collected in 4-oz, wide-mouth, amber, screw-top jars.	A 100-increment sample was collected randomly over the entire DU (e.g., using a systematic sampling) using CMIST. Typically, 1–2 kg of soil was collected in clean, large (e.g., 15 × 15 in., 6 mm thick) polyethylene plastic bags sealed with Ty-wraps.
Sample Drying	Not performed.	Samples were air-dried at room temperature by spreading them onto trays to form a relatively thin, uniform slab.
Sieving	Not performed.	Samples were passed through a #10 (2-mm) sieve. Both size fractions were weighed and a less than 2 mm fraction was additionally processed.

Activity	Conventional Grab Sampling	Incremental Sampling Method
Milling	Not performed although disaggregation with a mortar and pestle is sometimes performed.	Samples were milled using a puck mill for 5 x 60 s.
Laboratory Subsampling	A single aliquot was scooped from the top of the container for digestion and analyses.	After milling, the soil was spread onto a large tray to form a thin slab of material of uniform thickness. With a flat spatula, at least 20 small aliquots “increments” were randomly collected over the entire slab to prepare a subsample for digestion and analysis.
Subsample Mass	1-g wet weight.	2-g dry weight.
Analysis	EPA Method 6010.	EPA Method 6010 (EPA Method 8330B for Firing Point sample from Fort Wainwright).

Collection of ISM surface soil samples followed the methodology outlined in Section 2.1 *Technology Descriptions*; and all the steps, including sample preparation, are summarized in Table 1. We collected the ISM samples in plastic bags by combining 100 increments with an approximate total mass of 1–2 kg. All samples for this demonstration were processed and digested at CRREL. At the laboratory, the ISM samples were air dried and passed through a 10-mesh sieve prior to subsampling (e.g., and subsequent extraction and analysis for metals or explosives). We processed the explosives using Method 8330B; the primary compounds of interest for the explosives testing were nitroglycerine (NG); 2,4-dinitrotoluene; and 2,6-dinitrotoluene. For the ISM metal analyses, we subsampled the ISM samples by using the procedure described in Method 8330B (e.g., ground soil spread on a sheet of aluminum foil 1 to 2 cm thick and 20 aliquots selected randomly and combined for extraction and analysis). The metal ISM subsamples were digested and analyzed using a modified Method 3050B/6010B (Table 13). Energetic analysis was performed at CRREL, and all metals analysis and additional analytes were analyzed at the Environmental Laboratory (EL).

At each installation, we selected a background location close to the small-arms range but upwind of the prevailing wind direction. We collected triplicate 100-increment samples from this background DU, which covered an area of 0.5 acres (Table 12).

At Fort Wainwright, we collected 15 replicate ISM samples from the firing point and analyzed them for energetics and metals (Table 13). The intent

was to demonstrate that the metals ISM process would work with soils containing energetics. For each berm DU, we collected n = 15 ISM field replicates to evaluate total precision.

Table 13. Soil samples collected.

Component	Sample Type	Number of Field Increments	Number of Samples	Analyte	Military Installation	Decision Unit	Comment
Background Soil Sample	ISM	100	3	Metals, grain size, pH, CEC, TOC, moisture content	Fort Wainwright	Bkgd	General background soil characterization
	ISM	100	3		Kimama Training Site	Bkgd	
	ISM	100	3		Fort Stewart	Bkgd	
Firing Point Soil Sample	ISM	100	15	Energetics, Metals, grain size, pH, CEC, TOC, moisture content	Fort. Wainwright	FP	Firing Point assessment of energetics and metals
ISM and Conventional Soil Samples	Grab	1	48	Metals	Fort Wainwright	Berm Face	Conventional grab sampling metals
	ISM	100	15	Metals, grain size, pH, CEC, TOC, moisture content	Fort Wainwright	Berm Face	ISM sampling metals
	Grab	1	30	Metals	Kimama Training Site	Berm Face	Conventional grab sampling metals
	ISM	100	15	Metals, grain size, pH, CEC, TOC, moisture content	Kimama Training Site	Berm Face	ISM sampling metals
	Grab	1	33	Metals	Fort Eustis	Berm Face	Conventional grab sampling metals
	ISM	100	15	Metals, grain size, pH, CEC, TOC, moisture content	Fort Eustis	Berm Face	ISM sampling metals
ISM Reproducibility	ISM	50	30	Metals	Fort Wainwright	Berm Face	

Bkgd—background

CEC—cation exchange capacity

FP—firing point

ISM—Incremental Sampling Methodology

TOC—total organic carbon

Table 14. Analytical methods for sample analyses.

Analyte	Method	Container	Preservative	Holding Time
Metals	6010B/3050B	4–8-oz, wide-mouth glass jar	None	6 months
Explosives	8330B	Polyethylene bags, 15 x 15 in or 17 x 12 in, 6 mm thick, sealed with Ty-wraps	Ice to $4 \pm 2°C$	Samples extracted within 14 days, and extracts analyzed within 40 days following extraction
Total Organic Carbon (TOC)	Walkley-Black Method[2]	4-oz,wide-mouth glass jar	None	NA
Soil pH	SW-846 9045D	4-oz, wide-mouth glass jar	None	Samples should be analyzed as soon as possible
Cation Exchange Capacity (CEC)	ASTM D7503-10[1]	16-oz, wide-mouth glass jar	None	NA
Grain Size	ASTM D421/ASTM D422[1]	NA	None	NA
Moisture Content	ASTM D2216[1]	NA	None	NA

[1] ASTM 2003b

[2] Page 1982

NA—not applicable

5.6.1 Calibration of analytical equipment

The metal and explosive analyses complied with the quality assurance/quality control (QA/QC) criteria in the *DoD Quality Systems Manual (QSM) for Environmental Laboratories, Version 5.0* (DOD 2013) and the SW-846 methods (USEPA 2006), in that order of precedence. Appendix B provides all QA/QC results. Initially, we ran a calibration standard to assess the instruments' precision and also ran a calibration blank and an inter element standard. Once we analyzed the samples, we ran a calibration blank and a continuing check verification (CCV) standard after every 10 samples (Table 15). For each batch run, we prepared and analyzed a method blank, a laboratory control sample, a matrix spike (MS), a matrix duplicate, and a matrix spike duplicate (MSD). We conducted a post-serial dilution, serial dilution, or method of standard additions as needed.

Table 15. Quality control elements, frequency of implementation, and acceptance criteria for analysis of metals in soils.

Quality Control Element	Description of Element	Frequency of Implementation	Acceptance Criteria
Initial Calibration	Option 1—One standard and blank, and low-level check standard at MQL Option 2—Three standards and blank	Daily	Option 1—Low-level check standard ± 20% Option 2—r ≥ 0.995
Instrumental Precision	Percent RSD of 3 integrations (exposures)	Each calibration and calibration standards (ICV/CCV)	% RSD < 5
ICV	Mid-level (2nd source) verification	After initial calibration	% Recovery ± 10
ICB	Interference-free matrix to assess analysis contamination	After initial calibration	Analytes < MDL Check Sample (~2X MDL)
ICS	ICS-A—interferents only ICS-B—interferents and target analytes	Beginning of analytical sequence	% Recovery ± 20 for target analytes
CCB	Interference-free matrix to assess analysis contamination	Every 10 samples and at end of analytical sequence	Analytes < MDL, Check Sample (~2X MDL)
CCV	Mid-level verification	Every 10 samples and at end of analytical sequence	% Recovery ± 10
MB	Interference-free matrix to assess overall method contamination	1 per sample batch	Analytes < MDL, Check Sample (~2X MDL)
LCS	Interference-free matrix containing all target analytes	1 per sample batch	% Recovery = 80–120 SMF: % Recovery = 60–140
MS	Sample matrix spiked with all/subset of target analytes prior to digestion	1 per sample batch	% Recovery = 75–125
Matrix Duplicate or MSD	Refer to text for MD or MS	1 per sample batch	RPD ≤ 25%
PSD	Sample digestate spiked with all/subset of target analytes	As needed to confirm matrix effects	% Recovery = 75–125
SD	1:4 dilution analyzed to assess matrix effects	As needed to assess new and unusual matrices	Agreement between undiluted and diluted results ± 10%
MSA	Method of quantitation	As needed for samples with suspected or confirmed matrix effects	r ≥ 0.995

The number of SMF allowances depends upon the number of target analytes reported from the analysis. In the instance of 7 to 15 metals reported from the ICP analysis, one SMF is allowed to the expanded criteria presented.

CCB—continuing calibration blank	LCS—laboratory control sample	MSD—matrix spike duplicate
CCV—continuing calibration verification	MB—matrix blank	PSD—post serial dilution
ICB—initial calibration blank	MD—matrix duplicate	RPD—relative percent difference
ICS—inter element check standards	MDL—method detection limit	RSD—relative standard deviation
ICV—initial calibration verification	MS—matrix spike	SD—serial dilution
	MSA—method of standard additions	SMF—sporadic marginal failure

Figure 25 provides an analysis of the relative performance difference (RPD) for the soil matrix duplicates. With the exception of three RPDs that are less than 40% (for Sb, Ag and thallium [Tl]), all of the soil RPDs are less than 20%, meeting our QA/QC criteria.

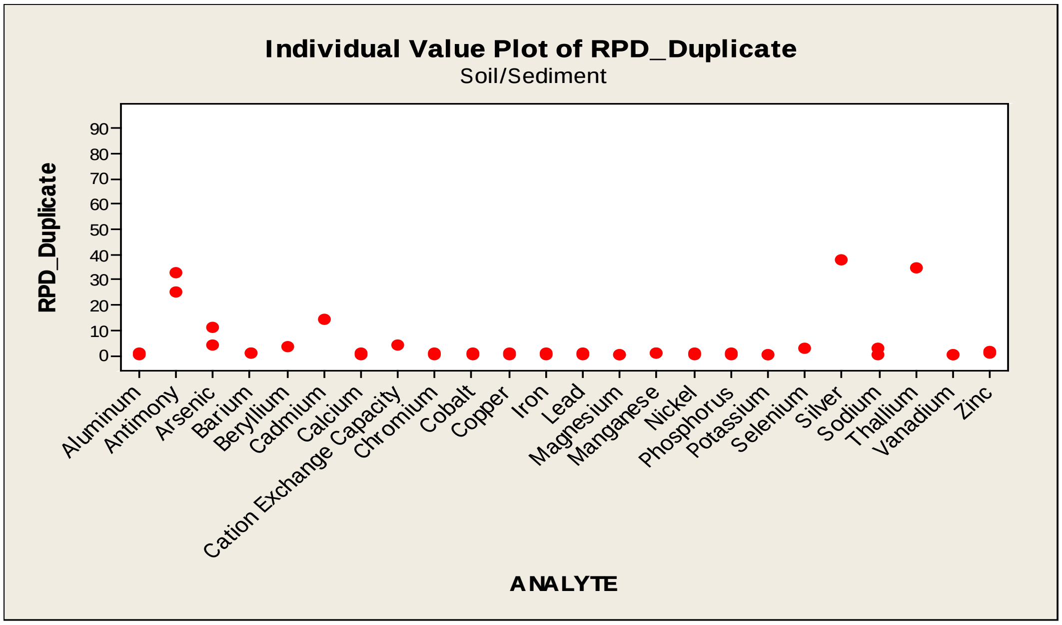


Figure 25. Matrix spike water recoveries for the metal analytes.

A plot of the MS recoveries for the water and soil samples indicate that all of the aqueous matrix spikes were within 80%–120% (Fig. 26and 27) and met our QA/QC performance criteria. All of the soil matrix spikes were within 80%–120% with the exception of the following analytes: Al, calcium (Ca), Fe, Pb, Mg, K, and phosphorus (P) (Fig. 27). However, most of the analytes are typically not contaminants of interest (especially Ca, K, and P). The non-compliant MS recoveries are likely owing to large native analyte concentrations relative to the spike concentrations. For example, an MS recovery for soil for Pb of 516% was obtained. The native analyte concentration is about 600 mg/kg, but the Pb spike concentration was only 40 mg/kg.

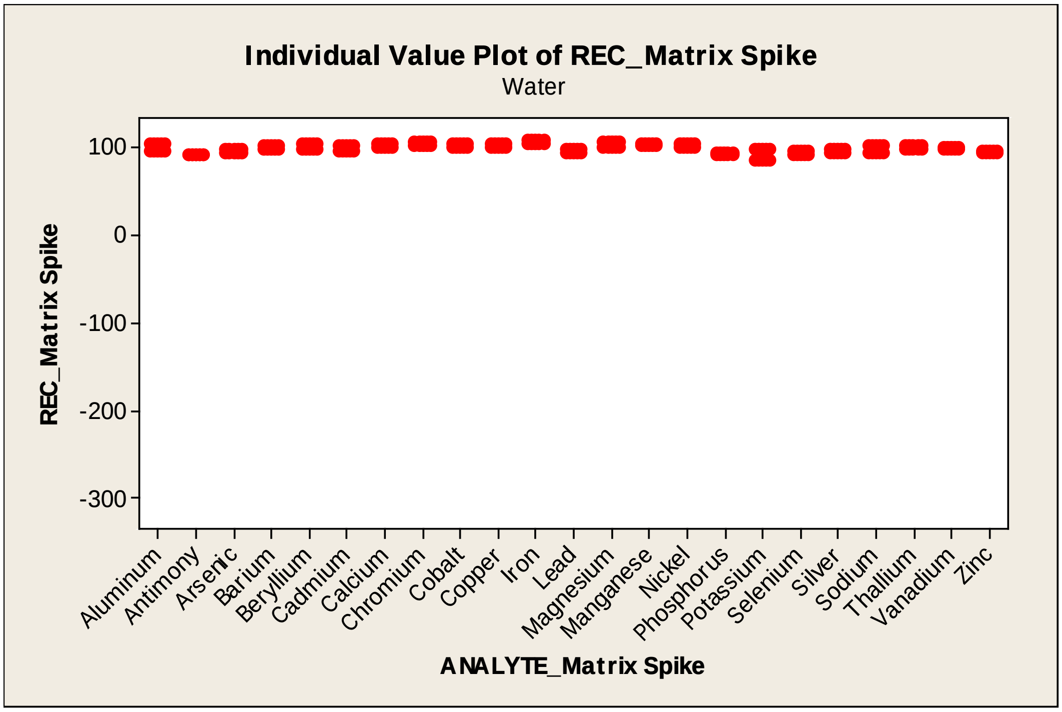


Figure 26. Matrix spike water recoveries for the metal analytes.

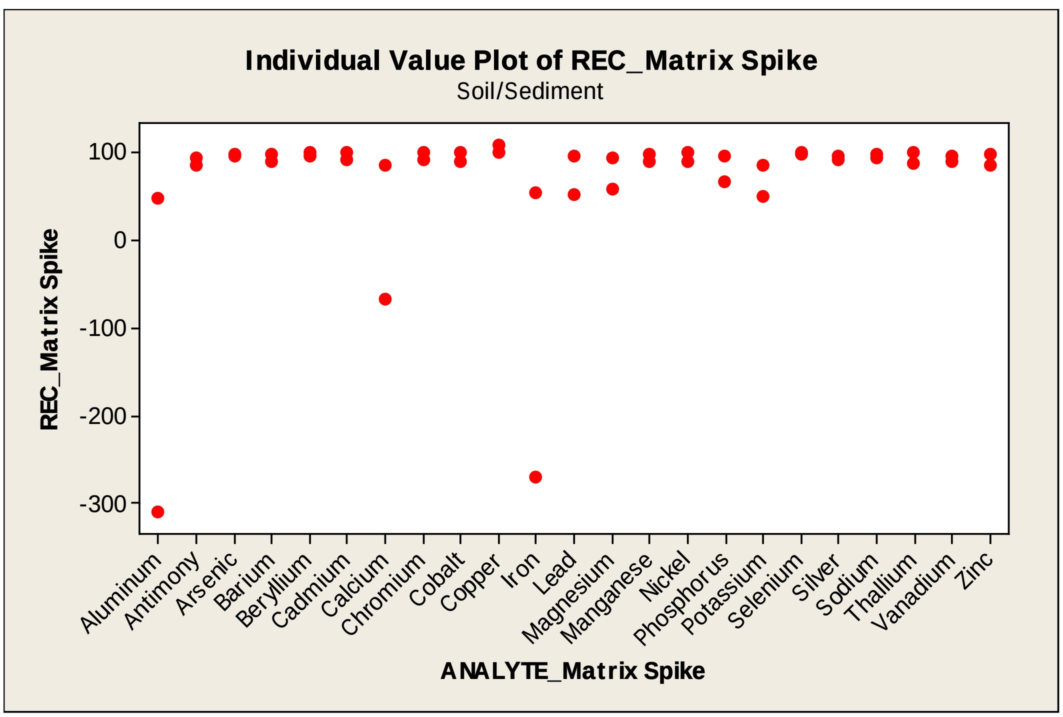


Figure 27. Matrix spike soil recoveries for the metal analytes.

5.6.2 Quality assurance sampling

Our team sampled each of the DUs by collecting 15 replicate ISM (field duplicate) samples both for an assessment of the technology and for QA purposes. We prepared a process blank sample for each sample batch submitted for analysis. The process blank consisted of the acid additions for Method 3050B minus the soil. We prepared pre- and post-glass blank samples to assess metal carryover from milling. Table 16 provides percent recovery acceptance criteria for both metal and energetic analysis. We analyzed milled MBs and LCSs for the metals for each batch of samples. The milled MBs and LCSs consisted of reagent water digested and analyzed in the same manner as the environmental samples and evaluated using the criteria in the QSM. Table 16 provides percent recovery acceptance criteria for both metal and energetic analysis. With the exception of several Cd LCS recoveries slightly below 80% (e.g., the lowest recovery was 77.8%), all LCS recoveries were well within the acceptance range of 80%–120% (Fig. 28).

Table 16. Percent recovery ranges for milled soil analyzed HPLC and ICP-OES.

Analyte	%Recovery Ranges Unground
Metals[2]	80–120
1,3,5-Trinitrobenzene (1,3,5-TNB)	75–125
1,3-Dinitrobenzene (1,3-DNB)	80–125
2,4-Dinitrotoluene (2,4-DNT)[2]	80–125
2,6-Dinitrotoluene (2,6-DNT)[2]	80–120
2,4,6-Trinitrotoluene (TNT)	55–140
2-Amino-4,6-dinitrotoluene (2-A-2,4-DNT)	80–125
2-Nitrotoluene (2-NT)	80–125
3-Nitrotoluene (3-NT)	75–120
4-Amino-2,6-dinitrotoluene (4-A-2,6-DNT)	80–125
4-Nitrotoluene (4-NT)	75–125
Hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX)	70–135
Nitrobenzene (NB)	75–125
Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine (HMX)	75–125
Nitroglycerin (NG)[2]	60–140[1]
Pentaerythritol tetranitrate (PETN)	60–140[1]
1-Chloro-3-nitrobenzene (surrogate)	60–140[1]

[1] There are no acceptance ranges for these compounds in the QSM.

[2] The primary analytes of interest.

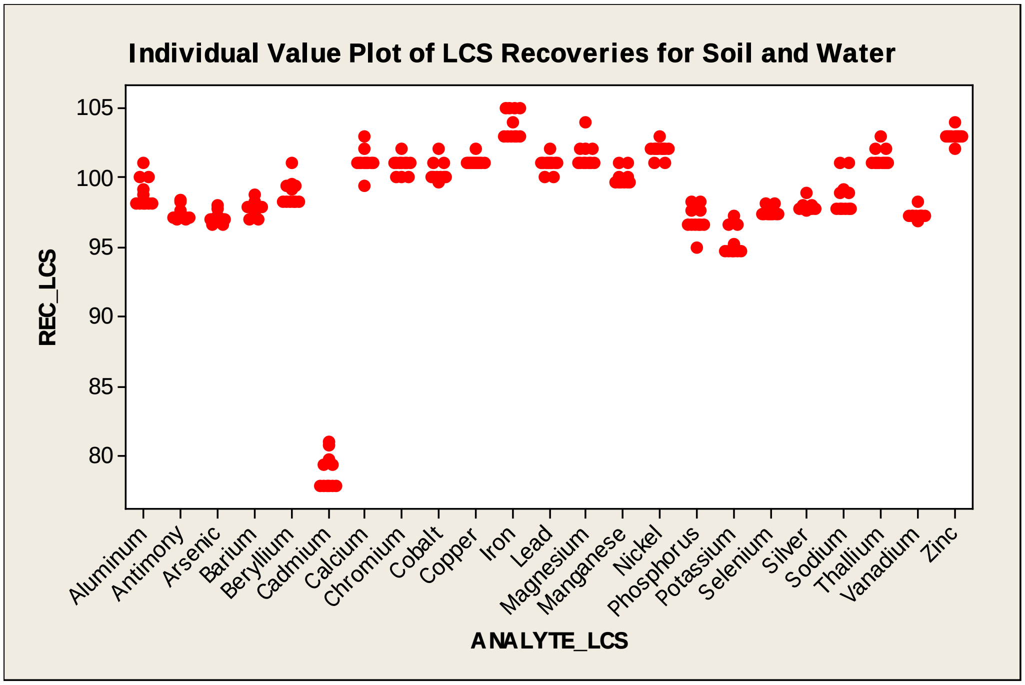


Figure 28. Laboratory control water and soil sample recoveries for the metals.

We milled and analyzed an LCS for metals purchased from Environmental Resource Associates (ERA). The LCS consisted of 500 g of soil that had been spiked with Cu, Pb, Sb, and Zn. Statistical acceptance ranges for the ground ERA LCS recoveries were not available; therefore, we used a tentative acceptance range of 70%–130% (Table 17). A total of five 2-g aliquots of Standard Reference Material (SRM) 2709 and SRM 2711 were digested with the environmental samples and analyzed for metals in separate preparation batches. To evaluate the results, we used the acceptance ranges supplied by the manufacturer. Ground glass that has been acid-washed was processed with each batch of environmental samples.

Table 17. Percent analyte recovery ranges for ground soil analyzed HPLC and ICP-OES.

Explosive	%Recovery Ranges Ground LCS[1]
Metals[3]	70–130[2]
1,3,5-Trinitrobenzene (1,3,5-TNB)	45–130
1,3-Dinitrobenzene (1,3-DNB)	60–130
2,4-Dinitrotoluene (2,4-DNT)[3]	50–130
2,6-Dinitrotoluene (2,6-DNT)[3]	45–140
2,4,6-Trinitrotoluene (TNT)	50–140
2-Amino-4,6-dinitrotoluene (2-A-2,4-DNT)	45–125

Explosive	%Recovery Ranges Ground LCS[1]
2-Nitrotoluene (2-NT)	55–130
3-Nitrotoluene (3-NT)	55–140
4-Amino-2,6-dinitrotoluene (4-A-2,6-DNT)	35–125
4-Nitrotoluene (4-NT)	50–140
Hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX)	45–130
Nitrobenzene (NB)	45–130
Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine (HMX)	40–130
Nitroglycerin (NG)[3]	60–140[2]
Pentaerythritol tetranitrate (PETN)	60–140[2]
1-Chloro-3-nitrobenzene (surrogate)	60–140[2]

[1] Acceptance ranges are rounded to the nearest 5% or 10% recovery. The upper acceptance limit for the LCS obtained from the QSM (DOD 2013) was used as the upper limit for the ERA standard.

[2] ERA did not establish acceptance ranges for these compounds.

[3] The primary analytes of interest.

5.6.3 Decontamination procedures

We did not use any specific decontamination procedures prior to entering and leaving any of the field sites. Conventional grab samples are considered independent; and thus, even when multiple samples are collected from within the same DU, decontamination of sampling tools is necessary between samples. Consequently, between the collection of each grab sample, we decontaminated the CMIST. Decontamination consisted of physically removing visible soil material stuck to the sampling device. This was followed with an isopropyl alcohol rinse of the CMIST corer and then triplicate deionized water rinse.

In the case of the ISM, the individual increments collected from within a DU make up the total sample. Consequently, there is no need for decontamination of sampling equipment between increments collected from within a DU. Replicate samples from the same DU are independent; however, the same sampling area is being evaluated through the collection of increments. Replicate samples from the same DU are designed to be statistically independent and collected as separate entities. To better guarantee this independence, the sampling equipment should be cleaned, if not decontaminated, between collection of replicate ISM samples from within a DU. As a best management practice, between collection of replicate sam-

ples within the same DU, we physically removed and wiped down with a paper laboratory wipe soil visibly adhered to the sampling tool.

The collection of samples from different DUs, such as between the firing point and the berm face, are independent samples and, thus, require decontamination of the sampling equipment between sampling the two DUs. The same decontamination procedures used for conventional grab sampling are used when sampling multiple DUs.

5.6.4 Sample documentation

The team used field logbooks to record salient information, such as description of each DU, its location (the global positioning system [GPS] coordinates of each corner of the rectangular coordinate DU), the number of increments, the coring diameter, the sampling depth, the date and time of sampling, etc. Each plastic bag containing an ISM sample was labeled with the information listed above both on the bag and on a 2.5 × 5-in. self-laminating tag. We labeled all grab sample jars and included the above information. Additionally, we maintained a laboratory logbook for sample preparation, digestion, and analysis. We combined all the information into a single Excel project file.

5.7 Sampling results

5.7.1 Kimama Training Site

The demonstration study at the Kimama TS found Cu and Pb in ISM surface soil samples from the small-arms Northern Berm in Training Area 3 at levels higher than the background sample. The mean Cu and Pb levels in the background ISM sample were 7.96 and 7.61 mg/kg, respectively (Table 18). In contrast, the mean Cu and Pb levels in the ISM berm sample were 35.3 and 292 mg/kg, respectively (Table 19). The mean Cu and Pb results for the grab samples were 23.0 and 493 mg/kg, respectively (Table 20). The grab sample mean for Pb (493 mg/kg) was nearly double that of the ISM mean (292 mg/kg). Also of note is the ISM mean and median for Pb are nearly the same (292 versus 287 mg/kg) whereas the mean and median Pb grab sample values (493 versus 73.5 mg/kg) differ by nearly a factor of seven, indicating the grab sample results are highly skewed. We collected a total of 15 replicate ISM and 30 grab samples; and the calculated RSD for Cu and Pb was significantly higher for the grab samples as compared to

the ISM (Tables 19 and 20), indicating greater precision with the ISM versus grab samples.

Figure 29 depicts the individual grab results for the berm face. The heavy dark line around the entire gridded area represents the DU. Based on the grab results, the western side of the Northern Berm had higher Cu, Pb, and Zn concentrations than the eastern side of the berm. ISM results are representative of the entire gridded area, or DU; and 15 replicate samples were collected from within the DU.

DU Boundary

Lead Results for Discrete Samples (mg/kg)											Legend
	75	1240	9060	1050	523	278	103	60	85	45	<50
	39	287	97	325	556	278	72	31	24	14	51-299
	11	19	30	40	142	198	28	49	25	13	>300
	ISM Mean = 292, ISM Median = 287, Discrete Mean = 493, Discrete Median = 73.5										
Copper Results for Discrete Samples (mg/kg)											
	20	57	74	32	41	42	26	15	18	18	<20
	14	24	21	19	39	42	14	16	13	13	21-39
	10	10	12	14	14	22	13	18	11	12	<40
	ISM Mean = 35., ISM Median = 29.2, Discrete Mean = 23.0, Discrete Median = 18.1										
Antimony Results for Discrete Samples (mg/kg)											
	<2.00	<2.00	<2.00	<2.00	<2.00	<2.00	<2.00	<2.00	2.2	<2.00	<0.02
	<2.00	<2.00	<2.00	<2.00	<2.00	<2.00	<2.00	<2.00	<2.00	<2.00	>0.021
	<2.00	<2.00	<2.00	<2.00	<2.00	<2.00	<2.00	<2.00	<2.00	<2.00	
	ISM Mean = <2.00, ISM Median = < 2.00, Discrete Mean = 19.5, Discrete Median = 3.01										
Zinc Results for Discrete Samples (mg/kg)											
	53	53	56	46	55	51	48	41	47	41	<25
	54	52	45	50	42	51	22	43	40	39	26-49
	45	44	42	46	44	51	44	42	37	40	>50
	ISM Mean = 30.0, ISM Median = 28.9, Discrete Mean = 45.4, Discrete Median = 44.9										

Figure 29. Lead, copper, antimony, and zinc (mg/kg) soil results for grab samples collected from the Kimama Training Site small-arms range berm face with Incremental Sampling Methodology comparisons.

Figures 30–32 show the distribution of the grab and ISM results for Pb, Cu, and Zn. Antimony is not shown because all of the ISM results were below the detection limit of 2 mg/kg. The majority of Sb grab results were also below the detection limit; however, there were several detections with an extreme degree of variability, resulting in a RSD of 172% (Table 18).

The Pb frequency distribution for the grab samples is skewed to the lower concentrations with a few high concentrations (Fig. 30). This skewed distribution is indicative of insufficient sample mass to accommodate the inherit heterogeneity in the sample. Thus, the sample variability overwhelms the analytical variability, resulting in an underestimation of the mean. The

increase in variability would make decisions based on a mean value difficult. The ISM sample results approximate a normal distribution although there is a slight skewness of the data to higher concentrations.

The Cu frequency distribution for the grab samples (Fig. 31) is similar to the Pb results. However, the ISM results do not exhibit a normal distribution. This may be due to insufficient milling of the sample. Copper has a tendency to plate out during the milling process. The Cu RSD for the ISM samples was 53% (Table 19), which is higher than our acceptance criteria of 30%. In contrast, the Cu RSD for the grab samples was 66% (Table 20).

Figure 32 shows the frequency distribution for Zn. The grab sample results exhibit a skewed distribution towards lower concentrations. In contrast, the ISM results exhibit a slightly skewed distribution towards higher concentrations. Zinc is a component alloyed with the Cu in the projectile casing, so some of the variance may be associated with incomplete milling of the Cu.

Appendix C provides individual sample results for all ISM and grab samples collected at Kimama TS, including all metal analytes. In addition, we conducted a detailed statistical analysis; and Appendix F reports the results for the Kimama TS.

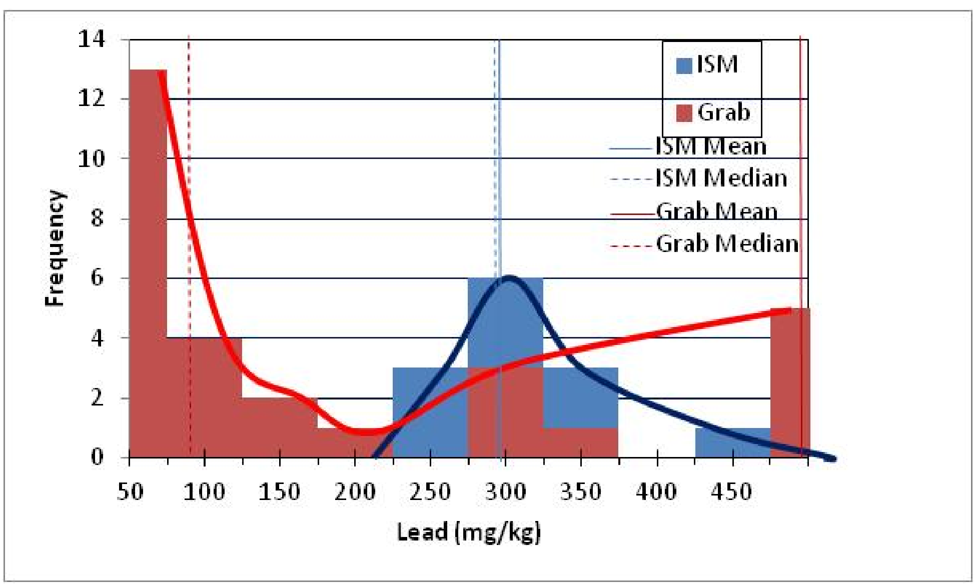


Figure 30. Frequency distribution for the lead (mg/kg) ISM and grab sample results collected from Kimama TS.

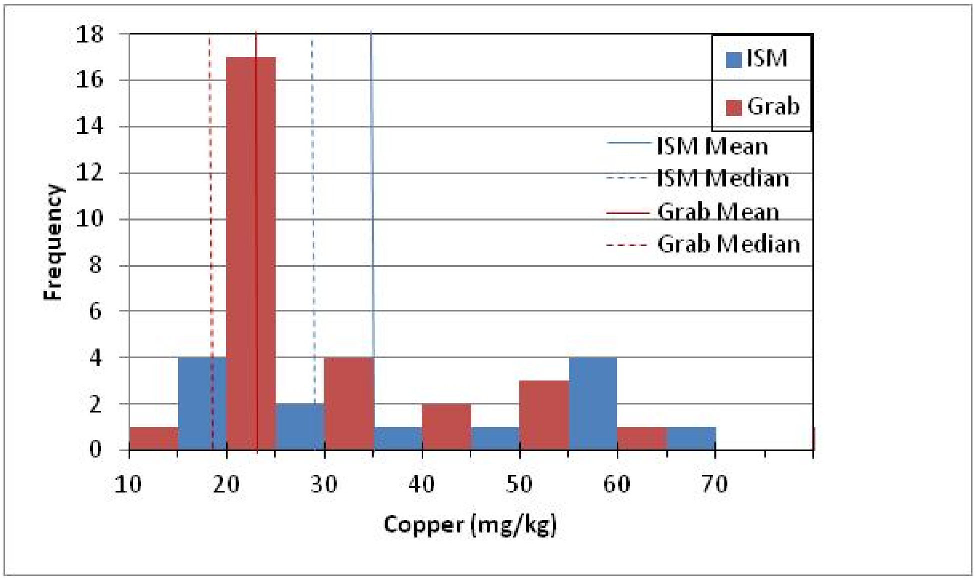


Figure 31. Frequency distribution for the copper (mg/kg) ISM and grab sample results collected from Kimama TS.

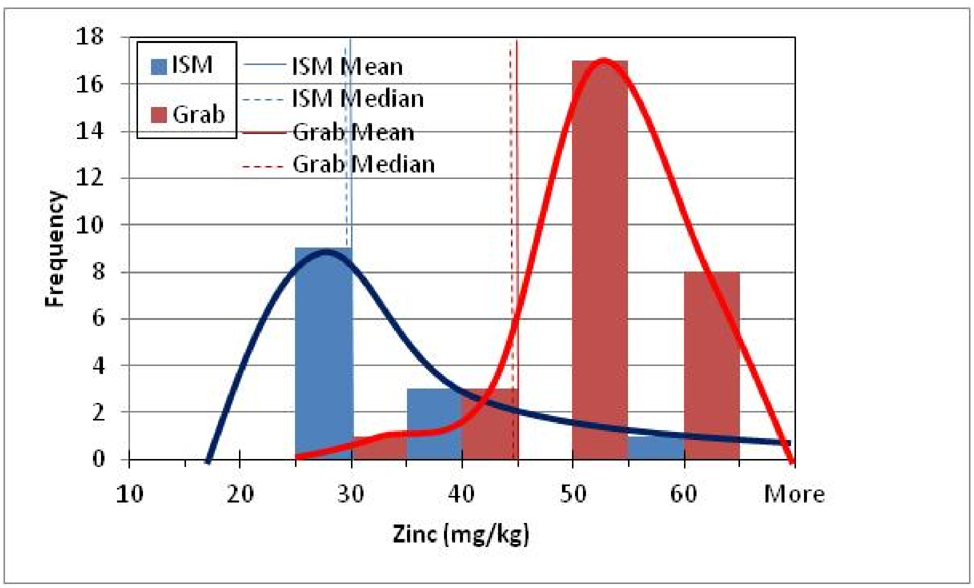


Figure 32. Frequency distribution for the zinc (mg/kg) ISM and grab sample results collected from Kimama TS.

Table 18. Incremental Sampling Methodology sample metals summary for Kimama Training Site background surface soil samples.

Background ISM	Mass (g)	Ag (mg/kg)	Al (mg/kg)	As (mg/kg)	Ba (mg/kg)	Be (mg/kg)	Ca (mg/kg)	Cd (mg/kg)	Co (mg/kg)	Cr (mg/kg)	Cu (mg/kg)	Fe (mg/kg)	K (mg/kg)	Mg (mg/kg)	Mn (mg/kg)	Na (mg/kg)	Ni (mg/kg)	P (mg/kg)	Pb (mg/kg)	Sb (mg/kg)	Se (mg/kg)	Silica (mg/kg)	S (mg/kg)	Th (mg/kg)	V (mg/kg)	Zn (mg/kg)
n	3	2	3	1	3	1	3	1	3	3	3	3	3	3	3	3	3	3	3	0	1	2	2	0	3	3
Mean	1639	1512	5333	2.99	67.6	0.232	1653	1.34	3.42	131	7.96	8310	1360	1653	145	151	8.66	402	7.61	<2.00	3.70	94.1	85.6	<2.00	16.2	33.8
Median	1659	1526	4180	2.99	52.8	0.232	1300	1.34	2.74	123	5.71	6500	1100	1270	112	121	6.80	325	5.57	<2.00	3.70	94.1	85.6	<2.00	13.3	25.8
Min	1480	1364	3960	2.99	52.0	0.232	1290	1.34	2.65	112	5.67	6430	1000	1240	111	121	6.79	315	5.17	<2.00	3.70	79.2	79.3	<2.00	12.4	25.6
Max	1778	1645	7860	2.99	98.0	0.232	2370	1.34	4.87	159	12.5	12000	1980	2450	211	211	12.4	566	12.1	<2.00	3.70	109	91.8	<2.00	23.0	49.9
STD	150	NA	2191	NA	26.3	NA	621	NA	1.26	24.6	3.93	3196	539	690	57.4	52.0	3.24	142	3.89	NA	NA	21.1	8.84	NA	5.88	14.0
RSD	9	NA	41	NA	39	NA	38	NA	37	19	49	38	40	42	40	34	37	35	51	NA	NA	22	10	NA	36	41

Table 19. Incremental Sampling Methodology metals summary for Kimama Training Site small-arms range berm surface soil samples.

ISM	Mass (g)	Ag (mg/kg)	Al (mg/kg)	As (mg/kg)	Ba (mg/kg)	Be (mg/kg)	Ca (mg/kg)	Cd (mg/kg)	Co (mg/kg)	Cr (mg/kg)	Cu (mg/kg)	Fe (mg/kg)	K (mg/kg)	Mg (mg/kg)	Mn (mg/kg)	Na (mg/kg)	Ni (mg/kg)	P (mg/kg)	Pb (mg/kg)	Sb (mg/kg)	Se (mg/kg)	Silica (mg/kg)	S (mg/kg)	Th (mg/kg)	V (mg/kg)	Zn (mg/kg)
n	15	0	14	3	14	1	14	1	14	14	14	14	14	14	14	14	14	14	14	0	1	13	13	1	14	14
Mean	881	<2.00	5051	2.30	58.6	0.279	1329	1.41	3.16	141	35.3	7167	1419	1437	129	146	8.04	348	292	<2.00	3.90	110	67.4	0.025	14.0	30.0
Median	861	<2.00	4705	2.06	54.6	0.279	1250	1.41	2.96	133	29.2	6710	1325	1340	121	135	7.49	329	287	<2.00	3.90	119	67.6	0.025	13.2	28.8
Min	801	<2.00	4580	2.02	53.3	0.279	1200	1.41	2.89	105	13.0	6570	1240	1310	117	121	7.33	323	220	<2.00	3.90	81.1	62.8	0.025	12.6	25.7
Max	1089	<2.00	9290	2.83	106	0.279	2380	1.41	5.57	215	65.5	12900	2570	2690	236	254	14.2	599	428	<2.00	3.90	143	72.2	0.025	24.3	53.1
STD	74.5	NA	1226	0.457	13.7	NA	304	NA	0.697	27.8	18.7	1657	337	361	31.0	33.4	1.79	72.4	52.1	NA	NA	20.7	3.00	NA	2.99	6.91
RSD	8	NA	24	20	23	NA	23	NA	22	20	53	23	24	25	24	23	22	21	18	NA	NA	19	4	NA	21	23

Table 20. Grab sample metals summary for Kimama Training Site surface soil samples.

Grab Grid Node	Mass (g)	Ag (mg/kg)	Al (mg/kg)	As (mg/kg)	Ba (mg/kg)	Be (mg/kg)	Ca (mg/kg)	Cd (mg/kg)	Co (mg/kg)	Cr (mg/kg)	Cu (mg/kg)	Fe (mg/kg)	K (mg/kg)	Mg (mg/kg)	Mn (mg/kg)	Na (mg/kg)	Ni (mg/kg)	P (mg/kg)	Pb (mg/kg)	Sb (mg/kg)	Se (mg/kg)	Silica (mg/kg)	S (mg/kg)	Th (mg/kg)	V (mg/kg)	Zn (mg/kg)
n	30	0	30	29	30	0	30	0	30	30	30	30	30	30	30	30	30	30	30	4	1	30	30	0	30	30
Mean	100	<2.00	6835	3.51	68.7	<2.00	1776	<2.00	4.50	15.8	23.0	9906	1768	2179	198	65.9	10.5	542	493	19.598	2.21	167	92.0	<2.00	18.0	45.4
Median	99	<2.00	6955	3.31	69.4	<2.00	1755	<2.00	4.6	15.9	18.1	10050	1835	2185	197.5	64.85	10.7	527	73.5	3.015	2.21	176.5	80.5	<2.00	18.15	44.9
Min	66.5	<2.00	3030	2.62	30.3	<2.00	892	<2.00	2.16	7.81	9.83	4690	799	1030	93.9	28.7	5.15	243	11.1	2.16	2.21	85.3	47.9	<2.00	8.35	21.8
Max	135	<2.00	8150	7.8	89.2	<2.00	2580	<2.00	5.09	18.5	74.2	11600	2120	2530	278	88.9	12.2	727	9060	70.2	2.21	236	195	<2.00	20.8	56.2
STD	17	NA	908	0.950	10.4	NA	339	NA	0.539	1.88	15.20	1187	244	276	28.8	10.8	1.26	95.0	1645	33.7	NA	47.3	39.8	NA	2.26	6.88
RSD	17	NA	13	27	15	NA	19	NA	12	12	66	12	14	13	15	16	12	18	334	172	NA	28	43	NA	13	15

5.7.2 Fort Eustis

At the 1000-in. Firing Range on Fort Eustis, Cu and Pb levels were elevated in grab and ISM surface soil samples for the entire berm face (Tables 21 and 22). The mean Cu and Pb results for the grab samples were 43.3 and 434 mg/kg, respectively (Table 21). The mean Cu and Pb results with ISM were 51.2 and 496 mg/kg, respectively (Table 21). Unlike the Kimama TS results, the mean values for the grab and ISM samples are similar for both Cu and Pb. Although the ISM mean and median for Pb values are nearly the same (496 versus 509 mg/kg), the mean and median Pb grab sample values (434 versus 94.3 mg/kg) differ by nearly a factor of five, indicating the grab sample results are highly skewed. We collected a total of 3 replicate ISM and 33 grab samples, and the calculated RSD for Cu and Pb was significantly higher for the grab samples (298% and 350%) as compared to the ISM (Tables 21 and 22), indicating greater precision with the ISM versus grab samples. However, the performance criteria of less than 30% RSD was not met with the ISM samples, suggesting an insufficient sample mass resulting from an insufficient number of increments per sample, an insufficient mass per increment collected, or an insufficient mass for the digestion aliquot. The RSDs for Cu and Pb with ISM were 104% and 72%.

Because previous SI data indicated most of the Cu and Pb was concentrated on the right side of the berm, referred to as Hostspot 1 by URS (2010) (Fig. 14), we conducted a focused sampling effort in this area as well. The team collected a total of 12 grab and 15 ISM samples from the first four grids (right side of Fig. 33). We sampled the first four western grids (1–4, 12–15, and 23–26) using ISM with the collection of 15 field replicates. Tables 23 and 24 present a summary of the results. The mean Cu and Pb results for the grab samples were 93.5 and 1002 mg/kg, respectively (Table 21). The mean Cu and Pb results with ISM were 114 and 932 mg/kg, respectively. As expected, the mean Pb level was higher than the ISM Pb level for the entire berm. Figure 32 depicts the individual grab results for the berm face. The western side (right side) of the Northern Berm had higher Cu, Pb, and Zn concentrations than the eastern side of the berm.

The Pb distribution of the grab samples grid by grid (Fig. 33) is slightly different than the grab sample distribution (Fig. 16) reported by URS (2010). These differences are the result of heterogeneous distribution of Pb and indicate the inability of the grab samples to accommodate this heterogene-

ity. Figure 33 indicates that the Pb grab sample distribution is skewed to the lower concentrations with several large outliers, including one of 8770 mg/kg (Table 23). This is the reason why the grab sample mean is significantly different than median: 1002 and 212 mg/kg, respectively (Fig. 32, Table 23). In contrast, the Pb ISM data exhibits a normal distribution with the mean and median Pb values nearly the same at 932 and 934 mg/kg, respectively (Fig. 33, Table 24).

Lead Results for Discrete Samples (mg/kg)											Legend
49	20	31	117	149	222	368	199	227	1360	422	<50
59	25	55	53	137	488	262	173	224	360	8770	51-299
25	18	56	18	34	53	51	49	46	95	94	>300
ISM Mean = 496, ISM Median = 509, Discrete Mean = 434, Discrete Median = 94.3											

Copper Results for Discrete Samples (mg/kg)											
7.2	7.9	7.3	13	17	45	33	48	33	69	69	<20
8.1	7.3	8.2	11	18	31	22	19	23	47	755	21-39
9.0	8.4	8.4	11	11	13	11	12	12	17	18	<40
ISM Mean = 51.2, ISM Median = 44.9, Discrete Mean = 43.3, Discrete Median = 13.2											

Antimony Results for Discrete Samples (mg/kg)											
<0.0200	<0.0200	<0.0200	<0.0200	<0.0200	0.08	0.10	<0.0200	<0.0200	4.0	1.7	<0.02
<0.0200	<0.0200	<0.0200	<0.0200	<0.0200	<0.0200	0.34	0.02	<0.0200	12	70	0.021-2
<0.0200	<0.0200	<0.0200	<0.0200	<0.0200	<0.0200	<0.0200	<0.0200	<0.0200	<0.0200	<0.0200	>2.0
ISM Mean = 0.850 ISM Median = 0.850 Discrete Mean = 11.0, Discrete Median = 1.01											

Zinc Results for Discrete Samples (mg/kg)											
25	33	28	25	26	48	29	25	22	29	31	<25
32	32	21	29	35	23	29	30	22	25	37	26-49
29	28	25	26	26	13	25	21	22	45	41	>50
ISM Mean = 34.5, ISM Median = 34.6, Discrete Mean = 28.6, Discrete Median = 27.6											

Figure 33. Lead, copper, antimony, and zinc (mg/kg) soil results for grab samples collected from the 1000-in. Firing Range at Fort Eustis with Incremental Sampling Methodology comparisons.

Figure 34 shows the frequency distribution for Cu and indicates the grab sample results are skewed towards the lower concentrations and the ISM to the higher concentrations. The grab sample mean and median values of 93.5 and 28.2 mg/kg, respectively (Table 23), vary considerably. Similar to what was observed at Kimama TS, the grab sample Cu results likely are influenced by insufficient sample mass; and the ISM results are skewed due to incomplete milling. The median and mean ISM Cu values of 114 and 101 mg/kg, respectively (Table 24), are quite close.

Figure 35 depicts the frequency distribution for Sb. The grab sample results are highly skewed by the many non-detections and exhibit an extreme variability in values. In contrast, the ISM data yields a near normal distribution with a slight skewness to several low values. Unlike the grab sample mean and median values, 17.05 and 4.01 mg/kg, respectively

(Table 23), the ISM mean and median values, 6.96 and 6.41, respectively (Table 24), are quite close.

The Zn results (Fig. 36) show a highly skewed dataset towards lower concentrations for the grab sample results. In contrast, the ISM results exhibit a normal distribution with the mean and median values nearly identical.

Appendix D provides individual sample results for all ISM and grab samples collected at Fort Eustis, including all metal analytes. In addition, we conducted a detailed statistical analysis; and Appendix G reports the results for Fort Eustis.

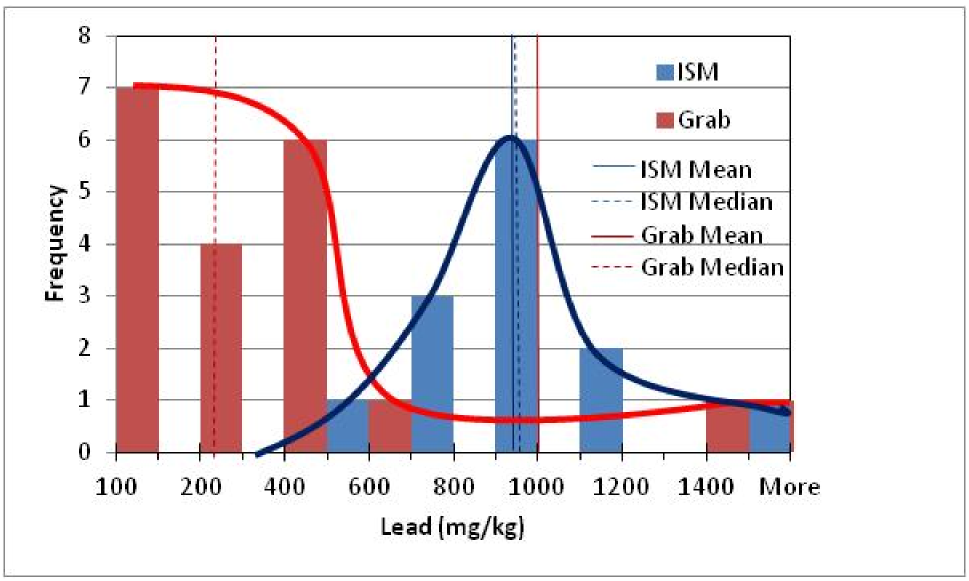


Figure 34. Frequency distribution for the lead (mg/kg) ISM and grab sample results for Fort Eustis (right side of the berm).

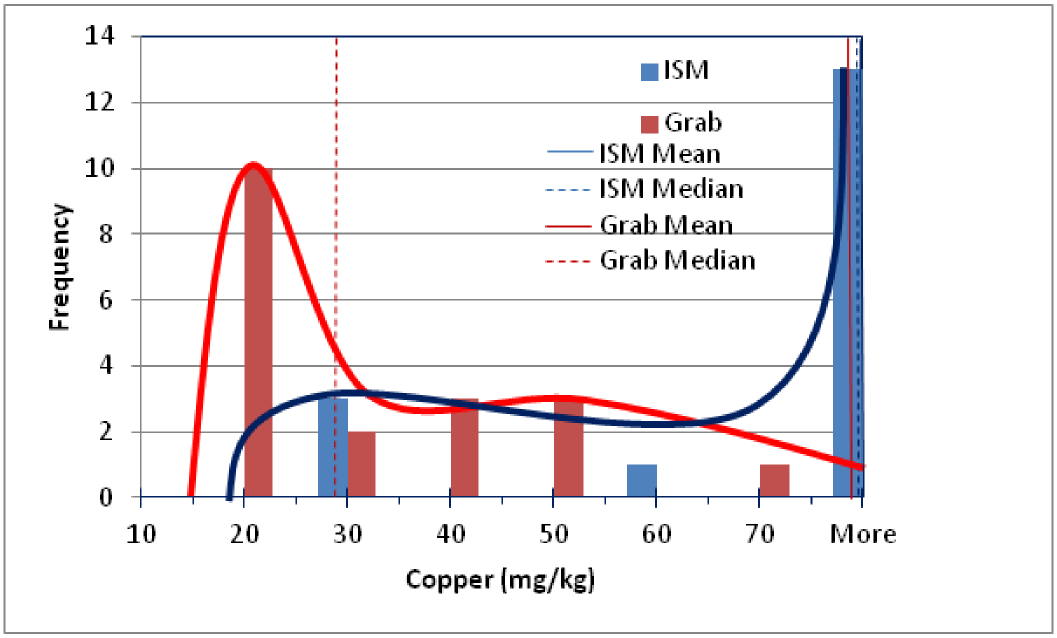


Figure 35. Frequency distribution for the copper (mg/kg) ISM and grab sample results for Fort Eustis (right side of the berm).

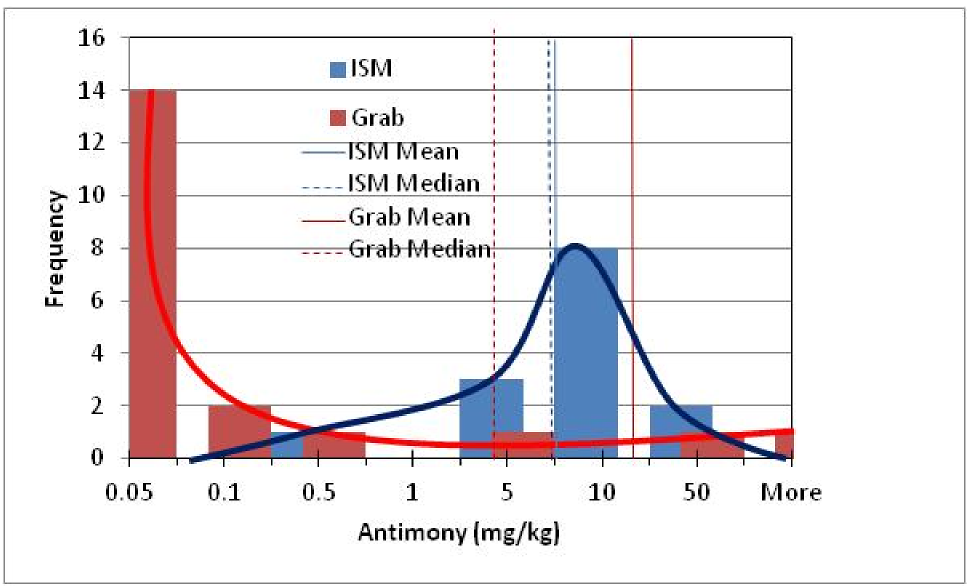


Figure 36. Frequency distribution for the antimony (mg/kg) ISM and grab sample results for Fort Eustis (right side of the berm).

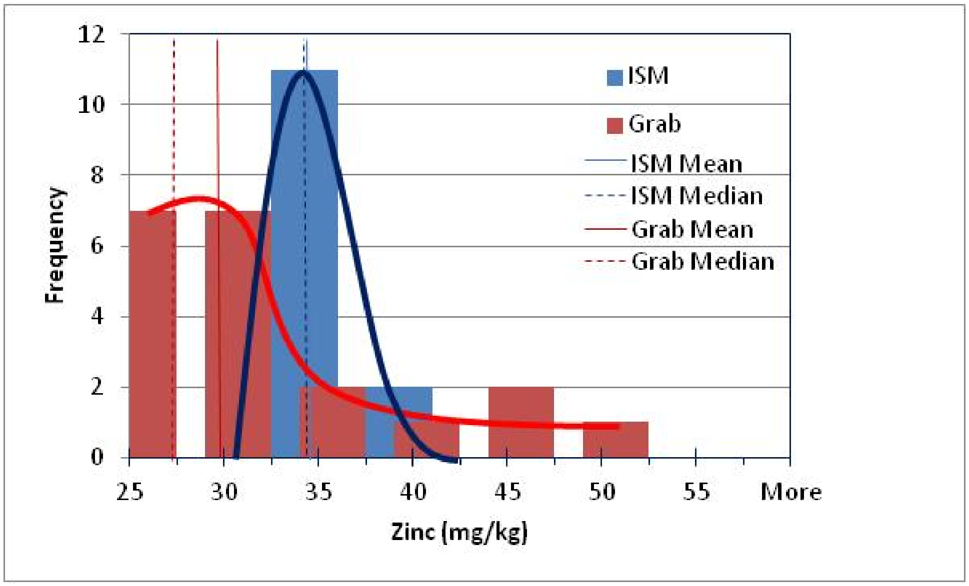


Figure 37. Frequency distribution for the zinc (mg/kg) ISM and grab sample results for Fort Eustis (right side of the berm).

Table 21. Grab sample metals summary for Fort Eustis surface soil samples from the entire 1000-in. Firing Range berm face.

Grab Entire Berm	Mass (g)	Ag (mg/kg)	Al (mg/kg)	As (mg/kg)	Ba (mg/kg)	Be (mg/kg)	Ca (mg/kg)	Cd (mg/kg)	Co (mg/kg)	Cr (mg/kg)	Cu (mg/kg)	Fe (mg/kg)	K (mg/kg)	Mg (mg/kg)	Mn (mg/kg)	Ni (mg/kg)	P (mg/kg)	Pb (mg/kg)	Sb (mg/kg)	Se (mg/kg)	Silica (mg/kg)	S (mg/kg)	Th (mg/kg)	V (mg/kg)	Zn (mg/kg)
n	33	32	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	8	33	0	0	7	33	33
Mean	78.8	0.707	7129	1.36	40.3	0.242	1547	0.770	2.75	8.11	43.3	6577	572	673	196	9.75	192	434	11.0	2.05	<2.00	<2.00	0.318	19.8	28.6
Median	22.0	0.450	7300	1.26	38.8	0.226	1160	0.735	2.67	8.53	13.2	6540	559	647	201	6.72	168	94.3	1.01	1.98	<2.00	<2.00	0.315	18.4	27.6
Min	1.00	0.108	4860	0.792	28.3	0.131	464	0.495	1.82	4.42	7.22	4460	396	483	34.8	4.07	125	17.6	0.023	0.791	<2.00	<2.00	0.080	11.3	21.0
Max	116	3.66	10500	2.34	52.7	0.411	6330	1.18	4.14	10.9	755	9440	751	1080	768	92.8	403	8770	69.6	3.26	<2.00	<2.00	0.499	33.6	48.1
STD	19.9	0.792	1288	0.398	7.22	0.069	1143	0.164	0.614	1.47	129	1258	90	108	137	15.1	64.1	1517	24.0	0.630	NA	NA	0.140	5.38	6.47
RSD	25	112	18	29	18	28	74	21	22	18	298	19	16	16	70	155	33	350	219	31	NA	NA	44	27	23

Table 22. Incremental Sampling Methodology metals summary for Fort Eustis surface soil samples from the entire 1000-in. Firing Range berm face.

ISM Entire Berm	Mass (g)	Ag (mg/kg)	Al (mg/kg)	As (mg/kg)	Ba (mg/kg)	Be (mg/kg)	Ca (mg/kg)	Cd (mg/kg)	Co (mg/kg)	Cr (mg/kg)	Cu (mg/kg)	Fe (mg/kg)	K (mg/kg)	Mg (mg/kg)	Mn (mg/kg)	Ni (mg/kg)	P (mg/kg)	Pb (mg/kg)	Sb (mg/kg)	Se (mg/kg)	Silica (mg/kg)	S (mg/kg)	Th (mg/kg)	V (mg/kg)	Zn (mg/kg)
n	3	0	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	2	3	0	0	0	3	3
Mean	1112	<2.00	9813	2.03	57.8	0.288	1893	0.968	4.35	355	51.2	10767	954	857	248	16.0	238	496	0.850	2.32	<2.00	<2.00	<2.00	24.7	34.5
Median	1106	<2.00	9820	2.08	57.7	0.286	1910	0.969	4.36	362	44.9	10700	956	861	252	15.3	239	509	0.850	2.24	<2.00	<2.00	<2.00	24.7	34.6
Min	1079	<2.00	9740	1.85	57.3	0.282	1860	0.963	4.21	321	39.5	10600	942	844	240	14.0	234	395	0.170	2.11	<2.00	<2.00	<2.00	24.4	34.3
Max	1153	<2.00	9880	2.17	58.3	0.296	1910	0.971	4.47	381	69.2	11000	964	866	253	18.7	242	583	1.53	2.61	<2.00	<2.00	<2.00	25.0	34.7
STD	413	NA	735	0.200	3.38	0.033	397	0.063	0.405	55.3	53.4	652	54.9	49.9	41.5	6.91	27.7	359	4.25	0.456	NA	NA	NA	1.24	1.75
RSD	37	NA	7	10	6	11	21	6	9	16	104	6	6	6	17	43	12	72	500	20	NA	NA	NA	5	5

Table 23. Grab sample metals summary for Fort Eustis surface soil samples from the right side (first 4 grids) of the 1000-in. Firing Range berm face.

Grab Right Side Berm	Mass (g)	Ag (mg/kg)	Al (mg/kg)	As (mg/kg)	Ba (mg/kg)	Be (mg/kg)	Ca (mg/kg)	Cd (mg/kg)	Co (mg/kg)	Cr (mg/kg)	Cu (mg/kg)	Fe (mg/kg)	K (mg/kg)	Mg (mg/kg)	Mn (mg/kg)	Ni (mg/kg)	P (mg/kg)	Pb (mg/kg)	Sb (mg/kg)	Se (mg/kg)	Silica (mg/kg)	S (mg/kg)	Th (mg/kg)	V (mg/kg)	Zn (mg/kg)
n	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	5	12	0	0	6	12	12
Mean	69.6	0.580	6498	1.49	36.6	0.216	1502	0.795	2.23	7.54	93.5	6021	517	635	112	15.6	195	1002	17.5	1.87	<2.00	<2.00	0.329	20.4	29.2
Median	69.9	0.466	6915	1.50	35.5	0.207	1175	0.733	2.18	7.52	28.2	6105	530	607	83.3	8.27	159	212	4.01	2.01	<2.00	<2.00	0.323	19.3	27.3
Min	42.9	0.184	4860	0.792	28.3	0.131	464	0.530	1.82	4.42	11.6	4460	396	483	34.8	4.53	128	46.3	0.023	0.791	<2.00	<2.00	0.080	12.0	21.0
Max	93.7	2.22	7920	2.31	51.5	0.321	3920	1.18	2.61	9.30	755	7270	604	1080	259	92.8	359	8770	69.6	2.76	<2.00	<2.00	0.499	28.3	44.9
STD	17.2	0.553	1141	0.436	7.55	0.058	1026	0.219	0.301	1.52	209	973	65.1	150	72.7	24.5	76.1	2472	29.5	0.647	NA	NA	0.150	5.14	7.94
RSD	25	95	18	29	21	27	68	28	14	20	224	16	13	24	65	157	39	247	169	35	NA	NA	45	25	27

Table 24. Incremental Sampling Methodology metals summary for Fort Eustis surface soil from the right side (first 4 grids) of the 1000-in. Firing Range berm face.

ISM Right Side Berm	Mass (g)	Ag (mg/kg)	Al (mg/kg)	As (mg/kg)	Ba (mg/kg)	Be (mg/kg)	Ca (mg/kg)	Cd (mg/kg)	Co (mg/kg)	Cr (mg/kg)	Cu (mg/kg)	Fe (mg/kg)	K (mg/kg)	Mg (mg/kg)	Mn (mg/kg)	Ni (mg/kg)	P (mg/kg)	Pb (mg/kg)	Sb (mg/kg)	Se (mg/kg)	Silica (mg/kg)	S (mg/kg)	Th (mg/kg)	V (mg/kg)	Zn (mg/kg)
n	14	6	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	0	0	14	14	14
Mean	485	0.254	8781	2.30	53.6	0.240	2348	0.921	3.98	435	114	10729	911	851	169	25.2	259	932	6.96	2.48	<2.00	<2.00	0.086	25.3	34.4
Median	484	0.148	8815	2.30	53.2	0.235	2320	0.921	4.04	435	101	10800	919	862	167	23.7	262	934	6.41	2.44	<2.00	<2.00	0.083	25.3	34.3
Min	417	0.035	7940	2.04	50.2	0.214	2110	0.839	3.68	347	53.9	10100	817	773	152	17.1	217	461	0	1.96	<2.00	<2.00	0.032	23.8	32.3
Max	574	0.747	9320	2.43	57.9	0.274	2610	0.990	4.21	486	207	11200	962	914	193	37.0	288	1540	16.3	3.41	<2.00	<2.00	0.139	26.1	36.5
STD	36.7	0.275	383	0.097	2.13	0.018	151	0.041	0.149	34.1	50.3	281	43.9	42.7	13.5	6.30	21.0	275	4.15	0.376	NA	NA	0.037	0.69	1.30
RSD	8	108	4	4	4	8	6	4	4	8	44	3	5	5	8	25	8	30	60	15	NA	NA	43	3	4

5.7.3 Fort Wainwright

At the Range 16 Record Range at Fort Wainwright, Cu and Pb levels in the background surface soil sample (Table 25) appear to be at similar levels as the ISM entire berm sample, suggesting the location selected behind the firing point has been anthropogenically impacted. However, Cu and Zn were detected in ISM surface soil samples from entire berm (Table 26) at levels higher than the ISM firing point sample (Table 27). The mean Cu and Pb levels in the background ISM sample were 38.2 and 416 mg/kg, respectively (Table 25). In contrast, the mean Cu and Pb levels in the ISM firing point sample were 135 and 50.5 mg/kg, respectively (Table 26). At the berm, Cu and Pb levels were 92 and 453 mg/kg, respectively (Table 27). In addition to the metals, we detected NG at the firing points with a mean concentration of 335 mg/kg. The RSD for the firing point ISM results were right at the performance objective of 30% for the metals of interest and NG. The performance objective was met at the berm for Pb and Zn with ISM. However, the Cu value of 64% RSD is above our acceptance criteria. It has been our observation that Cu has a tendency to plate out in the puck mill. It is possible that a longer milling interval, greater than 300 s, would result in better precision. The following analytes (Ag, Be, Cd, and Th) had 2 or fewer detections below the reporting limit and, thus, were not included in the summary tables (Tables 25–33).

The mean Cu, Pb, Sb, and Zn results for the entire berm grab samples were 81.0, 432, 14.0, and 52.6 mg/kg, respectively (Table 28). The entire berm grab sample mean (432 mg/kg) for Pb was similar to that observed with ISM (453 mg/kg). The entire berm ISM mean and median for Pb are nearly the same (453 versus 468 mg/kg). A frequency distribution plot for Pb indicates a near normal distribution (Fig. 38) whereas the mean and median Pb grab sample values (432 versus 85.7 mg/kg) differ by nearly a factor of five, indicating the grab sample results are highly skewed (Fig. 38). A large number of low Pb concentration results are evident for the grab samples with several very high concentrations. The frequency distribution for the Cu grab samples (Fig. 38) is similar to Pb. The grab Cu mean and median estimates, 81.0 and 27.5, respectively vary by a factor of three (Table 28, Fig. 39). The ISM antimony results were all less than the detection limit of 2 mg/kg (Fig. 40) In contrast, the mean and median grab sample estimates were 14.0 and 7.41 mg/kg, respectively (Table 28). The frequency distribution plot for Cu indicates a near normal distribution for

the grab samples with a few outliers of higher concentration (Fig. 39). The Zn grab sample results suggest a skewed population with a number of very high values (Fig. 41). The mean and median estimates are 52.6 and 47.9 mg/kg, respectively (Table 28). The ISM sample distribution looks similar to the grab samples with slightly less variability. The mean and median estimates are 55.8 and 53.8 mg/kg, respectively (Table 27).

We collected a total of 15 replicate ISM and 48 grab samples (Fig. 42), and the calculated RSD for Cu and Pb was significantly higher for the grab samples (218% and 226%, respectively) as compared to the ISM results of 66% and 24%, respectively (Tables 27), indicating greater precision with the ISM versus grab samples. The RSD for the Sb and Zn grab sample results is 97% and 42%, respectively (Table 28). The Zn grab sample RSD is 12%, and we observed no detections of Sb with the ISM samples. Figure 41 depicts the individual grab results for the berm face. The berms located at the center of the range had higher Cu, Pb, and Zn concentrations than the berms on the edge of the range.

We also summarized the grab sample results by sample location on the berm. For example, we combined all grab samples located in the upper left portion of the berm (Fig. 31; Table 29). Similarly, we summarized the results for the upper right of the berms (Table 30) and lower center (Table 31). It is clear based on the difference in mean Pb levels that the location on the berm where the grab samples are collected will have bearing on the results. The results suggest the upper right portion of the berm had the highest lead levels (Fig. 42). We should note that combining the results for a similar location on the berm still resulted in unacceptably high RSD.

Berm 11 was split vertically in half, and we sampled the left (Table 32) and right (Table 33) sides using ISM with 30 increments per sample. The mean Pb levels on the two sides of the berm were different (687 mg/kg versus 417 mg/kg) for 16 samples each. In comparison, the mean Pb level for the entire berm was 453 mg/kg. In contrast, the Pb value for individual grab sample from the upper left side of Berm 11 was 51 mg/kg and 39 mg/kg for the right side (Fig. 24). These grab sample values are significantly different than the ISM means.

Appendix E provides individual sample results for all ISM and grab samples from Fort Wainwright, including all metal analytes. In addition, we

conducted a detailed statistical analysis, and Appendix H reports the results for Fort Wainwright. Also, using ProUCL, we conducted some assessment of bias and the associated impact on UCL calculations; and Appendix H provides these results.

Table 25. Incremental Sampling Methodology surface soil metals summary for background samples collected near Range 16 Record Range located on Fort Wainwright.

ISM Background	Mass (g)	Al (mg/kg)	As (mg/kg)	Ba (mg/kg)	Ca (mg/kg)	Co (mg/kg)	Cr (mg/kg)	Cu (mg/kg)	Fe (mg/kg)	K (mg/kg)	Mg (mg/kg)	Mn (mg/kg)	Na (mg/kg)	Ni (mg/kg)	P (mg/kg)	Pb (mg/kg)	Sb (mg/kg)	Se (mg/kg)	Silica (mg/kg)	S (mg/kg)	V (mg/kg)	Zn (mg/kg)
n	3	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	0	0	1	1
Mean	2382	12400	15.4	208	12700	13.0	168	38.2	22700	2100	6260	721	562	25.8	828	416	<2.00	8.96	<2.00	<2.00	38.2	74.0
Median	2589	12400	15.4	208	12700	13.0	168	38.2	22700	2100	6260	721	562	25.8	828	416	<2.00	8.96	<2.00	<2.00	38.2	74.0
Min	1957	12400	15.4	208	12700	13.0	168	38.2	22700	2100	6260	721	562	25.8	828	416	<2.00	8.96	<2.00	<2.00	38.2	74.0
Max	2600	12400	15.4	208	12700	13.0	168	38.2	22700	2100	6260	721	562	25.8	828	416	<2.00	8.96	<2.00	<2.00	38.2	74.0
STDEV	368	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
RSD (%)	15	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Table 26. Incremental Sampling Methodology surface soil metals and energetics summary for the firing point at the Range 16 Record Range located on Fort Wainwright.

ISM Firing Point	Mass (g)	Al (mg/kg)	As (mg/kg)	Ba (mg/kg)	Ca (mg/kg)	Co (mg/kg)	Cr (mg/kg)	Cu (mg/kg)	Fe (mg/kg)	K (mg/kg)	Mg (mg/kg)	Mn (mg/kg)	Na (mg/kg)	Ni (mg/kg)	P (mg/kg)	Pb (mg/kg)	Sb (mg/kg)	Se (mg/kg)	Silica (mg/kg)	S (mg/kg)	V (mg/kg)	Zn (mg/kg)	NG (mg/kg)
n	15	14	14	14	14	14	14	14	14	14	14	14	14	14	14	7	0	14	14	14	14	14	15
Mean	2442	9930	6.63	172	5109	8.43	174	135	16907	1655	4594	286	385	179	309	50.5	<2.00	35.6	289	166	33.4	53.7	335
Median	2566	9780	6.67	168	5000	8.43	173	129	16800	1610	4585	282	366	174	305	45.7	<2.00	28.2	287	161	33.0	54.0	341
Min	2071	6460	4.34	117	3290	5.61	111	88.0	11500	1040	3110	194	13.6	26.1	27.4	37.3	<2.00	2.44	151	113	22.1	35.7	202
Max	2780	13400	9.02	268	6900	11.2	253	248	22500	2340	6090	383	787	343	610	76.2	<2.00	85.6	418	289	44.5	82.6	491
STDEV	230	3312	2.18	49.4	1671	2.71	56.8	40.0	5410	544	1479	91.7	385	158	286	15.4	NA	35.0	114	50.8	10.8	16.8	98.7
RSD (%)	9	33	33	29	33	32	33	30	32	33	32	32	100	88	93	30	NA	98	40	31	32	31	29

Table 27. Incremental Sampling Methodology surface soil metals summary for the entire berm at the Range 16 Record Range located on Fort Wainwright.

ISM Entire Berm	Mass (g)	Al (mg/kg)	As (mg/kg)	Ba (mg/kg)	Ca (mg/kg)	Co (mg/kg)	Cr (mg/kg)	Cu (mg/kg)	Fe (mg/kg)	K (mg/kg)	Mg (mg/kg)	Mn (mg/kg)	Na (mg/kg)	Ni (mg/kg)	P (mg/kg)	Pb (mg/kg)	Sb (mg/kg)	Se (mg/kg)	Silica (mg/kg)	S (mg/kg)	V (mg/kg)	Zn (mg/kg)
n	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	0	15	14	14	15	15
Mean	2403	12947	7.11	147	7027	10.7	288	92.0	21540	1809	5803	342	782	25.6	527	453	<2.00	2.84	206	89.4	41.9	55.8
Median	2341	13000	7.13	148	7070	10.8	293	72.9	21700	1820	5820	344	791	25.7	526	468	<2.00	2.48	203	87.5	41.7	53.8
Min	1995	12000	6.58	136	6570	10.3	246	39.5	20600	1590	5530	326	722	24.2	511	311	<2.00	2.31	157	78.7	39.7	49.8
Max	2847	13700	7.54	157	7270	11.0	319	247	22200	1970	5990	350	829	26.6	545	732	<2.00	7.90	277	103	44.1	74.3
STDEV	269	426	0.267	5.54	187	0.216	23.1	58.8	461	96.6	127	7.01	27.8	0.65	8.92	110	NA	1.41	40.7	7.32	1.17	6.96
RSD (%)	11	3	4	4	3	2	8	64	2	5	2	2	4	3	2	24	NA	49	20	8	3	12

Table 28. Grab surface soil sample metals summary for the entire berm at the Range 16 Record Range located on Fort Wainwright.

Entire Berm Grab	Mass (g)	Al (mg/kg)	As (mg/kg)	Ba (mg/kg)	Ca (mg/kg)	Co (mg/kg)	Cr (mg/kg)	Cu (mg/kg)	Fe (mg/kg)	K (mg/kg)	Mg (mg/kg)	Mn (mg/kg)	Na (mg/kg)	Ni (mg/kg)	P (mg/kg)	Pb (mg/kg)	Sb (mg/kg)	Se (mg/kg)	Silica (mg/kg)	S (mg/kg)	V (mg/kg)	Zn (mg/kg)
n	48	48	47	48	48	47	48	48	48	48	48	48	48	48	48	48	8	0	48	48	48	48
Mean	159	9980	8.85	104	5566	9.55	18.9	81.0	18143	1005	5235	291	475	21.1	508	432	14.0	<2.00	53.7	114	34.8	52.6
Median	162	10100	8.58	104	5535	9.47	19.2	27.5	18400	1015	5260	293	481	21.7	509	85.7	7.41	<2.00	49.2	98.6	35.4	47.9
Min	103	1060	6.23	10.6	529	7.24	2.04	2.58	1960	112	558	29.5	44.7	2.26	50.8	5.01	2.07	<2.00	3.83	9.13	3.59	4.88
Max	197	14200	12.7	170	9010	11.4	22.6	852	22700	1340	6540	384	744	25.3	673	4500	32.6	<2.00	135	581	41	146
STDEV	19.1	1655	1.36	19.5	1309	0.766	2.78	177	2820	175	817	48.9	117	3.14	84.8	978	13.5	NA	22.5	78.7	5.32	22.3
RSD (%)	12	17	15	19	24	8	15	218	16	17	16	17	25	15	17	226	97	NA	42	69	15	42

Table 29. Grab surface soil sample metals summary for the upper left portion of the berm at the Range 16 Record Range located on Fort Wainwright.

Upper Left Grab	Mass (g)	Al (mg/kg)	As (mg/kg)	Ba (mg/kg)	Ca (mg/kg)	Co (mg/kg)	Cr (mg/kg)	Cu (mg/kg)	Fe (mg/kg)	K (mg/kg)	Mg (mg/kg)	Mn (mg/kg)	Na (mg/kg)	Ni (mg/kg)	P (mg/kg)	Pb (mg/kg)	Sb (mg/kg)	Se (mg/kg)	Silica (mg/kg)	S (mg/kg)	V (mg/kg)	Zn (mg/kg)
n	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	2	0	16	16	16	16
Mean	163	10435	9.21	107	5821	9.70	19.3	56.2	18606	1055	5381	297	500	21.8	529	387	17.5	<2.00	60.4	143	35.8	51.9
Median	169	10050	8.84	104	5515	9.55	19.3	27.7	18400	1030	5285	293	480	21.7	516	109	17.5	<2.00	54.7	124	35.3	48.2
Min	103	9230	7.21	95.7	4700	8.82	18.1	23.5	17300	923	5110	254	319	20.0	457	5.23	2.43	<2.00	42.0	78.6	33.4	46.0
Max	184	14200	12.7	136	9010	11.4	21.1	457	22700	1340	6410	372	744	24.2	673	3820	32.6	<2.00	135	581	41.4	101
STDEV	22.1	1155	1.47	10.3	1078	0.665	0.818	107	1207	117	326	26.1	105	0.958	50.0	930	21.3	NA	23.6	119	2.20	13.2
RSD (%)	14	11	16	10	19	7	4	191	6	11	6	9	21	4	9	240	122	NA	39	83	6	25

Table 30. Grab surface soil sample metals summary for the upper right portion of the berm at the Range 16 Record Range located on Fort Wainwright.

Upper Right Grab	Mass (g)	Al (mg/kg)	As (mg/kg)	Ba (mg/kg)	Ca (mg/kg)	Co (mg/kg)	Cr (mg/kg)	Cu (mg/kg)	Fe (mg/kg)	K (mg/kg)	Mg (mg/kg)	Mn (mg/kg)	Na (mg/kg)	Ni (mg/kg)	P (mg/kg)	Pb (mg/kg)	Sb (mg/kg)	Se (mg/kg)	Silica (mg/kg)	S (mg/kg)	V (mg/kg)	Zn (mg/kg)
n	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	3	0	16	16	16	16
Mean	157	10061	8.76	102	5527	9.37	19.1	138	18244	1004	5243	290	477	21.2	503	649	22.7	<2.00	52.9	96.0	35.3	59.4
Median	159	10100	8.24	102	5540	9.36	19.0	25.5	18200	1015	5205	288	484	21.3	501	49.9	27.2	<2.00	46.7	95.5	35.5	46.9
Min	121	8310	6.32	88	4440	7.75	16.5	20.2	14700	856	4290	234	311	16.8	443	6.00	11.2	<2.00	23.9	69.4	29.3	35.6
Max	197	11200	12.3	116	8380	10.6	20.7	852	21700	1200	6170	363	680	23.0	620	4500	29.6	<2.00	111	123	40.2	146
STDEV	16.0	704	1.39	7.23	892	0.600	1.09	277	1409	83.7	378	25.7	77.6	1.42	43.9	1393	10.0	NA	20.7	15.2	2.36	33.4
RSD (%)	10	7	16	7	16	6	6	200	8	8	7	9	16	7	9	215	44	NA	39	16	7	56

Table 31. Grab surface soil sample metals summary for the lower middle portion of the berm at the Range 16 Record Range located on Fort Wainwright.

Lowe Center Grab	Mass (g)	Al (mg/kg)	As (mg/kg)	Ba (mg/kg)	Ca (mg/kg)	Co (mg/kg)	Cr (mg/kg)	Cu (mg/kg)	Fe (mg/kg)	K (mg/kg)	Mg (mg/kg)	Mn (mg/kg)	Na (mg/kg)	Ni (mg/kg)	P (mg/kg)	Pb (mg/kg)	Sb (mg/kg)	Se (mg/kg)	Silica (mg/kg)	S (mg/kg)	V (mg/kg)	Zn (mg/kg)
n	16	16	15	16	16	15	16	16	16	16	16	16	16	16	16	16	3	0	16	16	16	16
Mean	156	9443	8.58	102	5350	9.58	18.2	48.5	17579	955	5082	284	449	20.4	493	261	2.91	<2.00	47.8	105	33.4	46.6
Median	156	10350	8.64	107	5645	9.82	19.4	32.5	18750	1014	5445	306	471	22.1	521	112	3.04	<2.00	46.5	94.7	35.3	49.0
Min	115	1060	6.23	10.6	529	7.24	2.04	2.58	1960	112	558	29.5	44.7	2.26	50.8	5.01	2.07	<2.00	3.83	9.13	3.59	4.88
Max	181	11500	10.9	170	8740	11.4	22.6	295	22600	1270	6540	384	689	25.3	656	972	3.61	<2.00	88.7	292	41.3	75.6
STDEV	19.2	2492	1.21	32.0	1814	1.00	4.65	66.7	4570	264	1341	77.8	157	5.19	132	330	0.78	NA	22.9	61.5	8.64	13.7
RSD (%)	12	26	14	31	34	10	26	138	26	28	26	27	35	25	27	126	27	NA	48	59	26	29

Table 32. Incremental Sampling Methodology surface soil sample metals summary for the left side of Berm 11 at the Range 16 Record Range located on Fort Wainwright.

ISM Berm 11 Left	Mass (g)	Al (mg/kg)	As (mg/kg)	Ba (mg/kg)	Ca (mg/kg)	Co (mg/kg)	Cr (mg/kg)	Cu (mg/kg)	Fe (mg/kg)	K (mg/kg)	Mg (mg/kg)	Mn (mg/kg)	Na (mg/kg)	Ni (mg/kg)	P (mg/kg)	Pb (mg/kg)	Sb (mg/kg)	Se (mg/kg)	Silica (mg/kg)	S (mg/kg)	V (mg/kg)	Zn (mg/kg)
n	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	15	1	16	16	16	16	16
Mean	1208	12459	7.29	158	6539	10.4	281	143	20825	1833	5583	334	712	45.5	494	687	3.15	6.35	219	110	40.8	61.7
Median	782	12800	7.18	149	6710	10.6	292	129	21250	1820	5680	335	759	25.7	513	774	3.15	2.54	192	92.6	41.7	61.1
Min	552	6950	4.59	136	3570	5.95	119	44.7	12000	1170	3290	204	14.5	24.4	36.6	37.3	3.15	2.02	169	75.1	23.6	40.0
Max	2780	13400	8.67	211	7070	11.2	383	304	22500	2210	6070	377	811	343	585	1460	3.15	64.5	400	202	44.5	79.0
STDEV	826	1521	0.949	24.0	812	1.22	59.7	75.1	2413	243	636	38.8	188	79.3	125	386	NA	15.5	59.9	42.6	4.80	10.4
RSD (%)	68	12	13	15	12	12	21	52	12	13	11	12	26	174	25	56	NA	244	27	39	12	17

Table 33. Incremental Sampling Methodology surface soil sample metals summary for the right side of Berm 11 at the Range 16 Record Range located on Fort Wainwright.

ISM Berm 11 Right	Mass (g)	Al (mg/kg)	As (mg/kg)	Ba (mg/kg)	Ca (mg/kg)	Co (mg/kg)	Cr (mg/kg)	Cu (mg/kg)	Fe (mg/kg)	K (mg/kg)	Mg (mg/kg)	Mn (mg/kg)	Na (mg/kg)	Ni (mg/kg)	P (mg/kg)	Pb (mg/kg)	Sb (mg/kg)	Se (mg/kg)	Silica (mg/kg)	S (mg/kg)	V (mg/kg)	Zn (mg/kg)
n	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	15	0	16	16	16	16	16
Mean	1237	12308	7.28	163	6573	10.2	275	125	20544	1822	5508	333	719	41.9	524	417	<2.00	10.0	222	119	40.4	59.5
Median	848	12750	7.19	151	6805	10.5	296	118	21000	1810	5635	337	766	25.4	523	527	<2.00	2.33	199	90.3	41.7	59.6
Min	679	6220	3.56	74.4	3460	5.33	152	26.1	10900	883	2910	174	13.0	23.7	302	37.9	<2.00	2.06	151	61.8	20.9	27.2
Max	2672	13400	9.02	268	7150	11.1	361	254	22500	2340	6090	383	819	290	610	722	<2.00	125	397	289	44.4	82.6
STDEV	743	1692	1.27	43.8	866	1.34	56.1	64.4	2658	321	727	46.9	191	66.2	66.8	240	NA	30.7	67.9	64.1	5.45	12.0
RSD (%)	60	14	17	27	13	13	20	51	13	18	13	14	27	158	13	58	NA	306	31	54	13	20

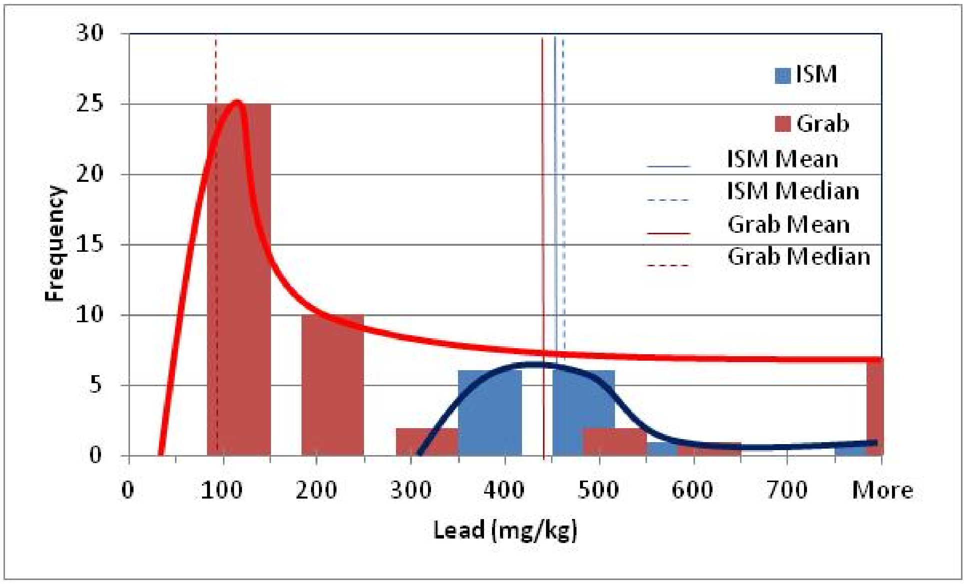


Figure 38. Frequency distribution for the lead (mg/kg) ISM and grab sample results for Fort Wainwright (right side of the berm).

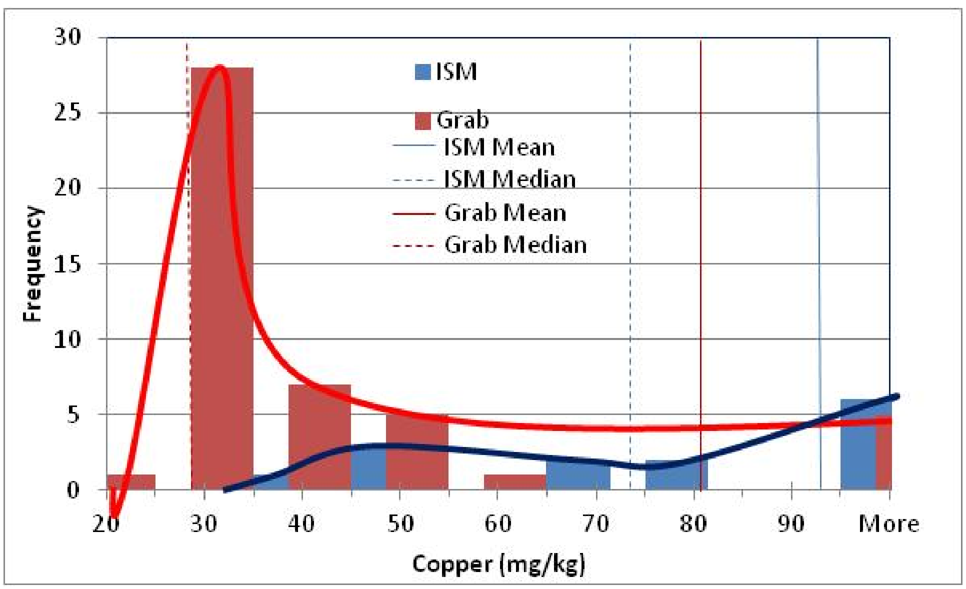


Figure 39. Frequency distribution for the copper (mg/kg) ISM and grab sample results for Fort Wainwright.

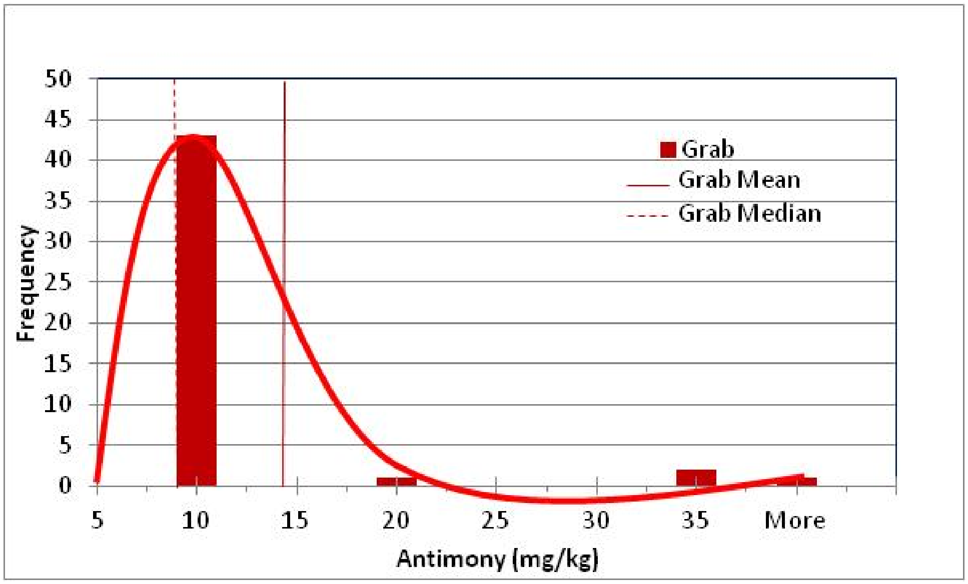


Figure 40. Frequency distribution for the antimony (mg/kg) ISM and grab sample results for Fort Wainwright.

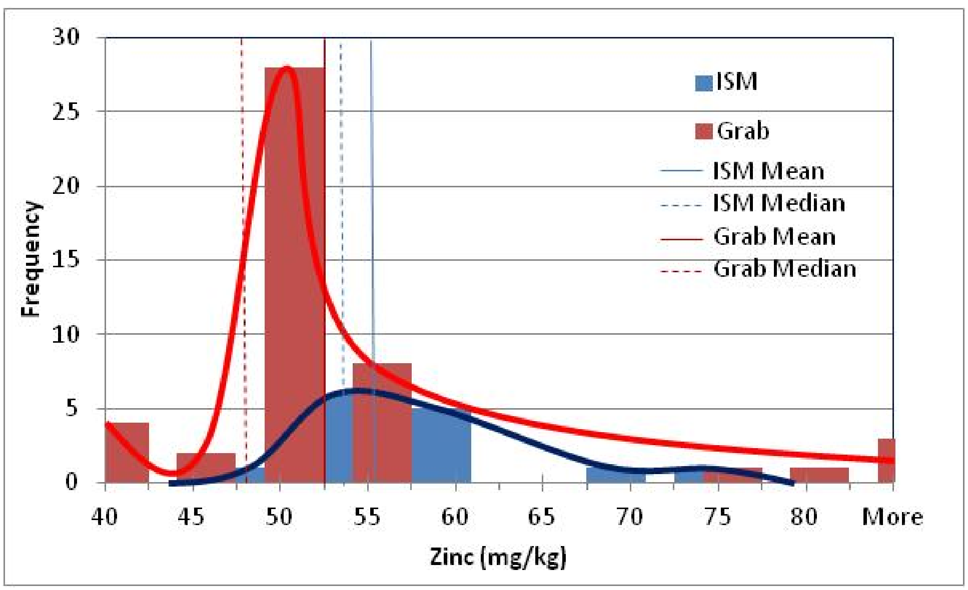


Figure 41. Frequency distribution for the zinc (mg/kg) ISM and grab sample results for Fort Wainwright.

Lead (mg/kg) Grab Results

Berm 1			Berm 2			Berm 3			Berm 4			Berm 5			Berm 6			Berm 7			Berm 8		
97		51	90		24	123		20	21		61	199		1670	70		180	497		79	264		3570
	109			41			18			114			929			145			972			432	

Berm 9			Berm 10			Berm 11			Berm 12			Berm 13			Berm 14			Berm 15			Berm 16		
5		6	3820		4500	51		39	121		72	156		49	74		25	565		12	37		31
	6			105			288			5			82			144			748			41	

Legend
<50
51-299
>300

ISM Mean = 458, ISM Median = 474, Discrete Mean = 432, Discrete Median = 86

Copper (mg/kg) Grab Results

Berm 1			Berm 2			Berm 3			Berm 4			Berm 5			Berm 6			Berm 7			Berm 8		
26		23	29		20	28		23	24		25	26		212	24		32	42		25	30		852
	34			41			44			27			295			30			53			36	

Berm 9			Berm 10			Berm 11			Berm 12			Berm 13			Berm 14			Berm 15			Berm 16		
28		27	457		825	24		24	24		27	28		23	35		24	49		27	26		26
	28			27			34			3			31			26			43			24	

<20
21-39
<40

ISM Mean = 91, ISM Median = 69, Discrete Mean = 81, Discrete Median = 28

Antimony (mg/kg) Grab Results

Not detected - likely dissolved and transported away

ISM Mean <0.02, ISM Median = <0.02, Discrete Mean = 14, Discrete Median = 7.4

Zinc (mg/kg) Grab Results

Berm 1			Berm 2			Berm 3			Berm 4			Berm 5			Berm 6			Berm 7			Berm 8		
47		49	51		45	48		47	48		48	49		70	47		46	52		46	51		140
	49			51			52			49			76			50			50			51	

Berm 9			Berm 10			Berm 11			Berm 12			Berm 13			Berm 14			Berm 15			Berm 16		
50		47	101		146	48		46	46		48	46		36	48		45	51		47	48		48
	49			47			46			5			45			40			38			48	

<25
26-49
>50

ISM Mean = 56, ISM Median = 53, Discrete Mean 53, Discrete Median = 48

Figure 42. Lead, copper, and zinc (mg/kg) soil results for grab samples collected from the Range 16 Record Range at Fort Wainwright with Incremental Sampling Methodology comparisons.

6 Performance Assessment

6.1 Sample reproducibility with Incremental Sample Methodology

A quantitative performance objective for ISM was to obtain reproducible sample results through collection and analysis of replicate field samples (Table 5). We developed two different statistical success criteria for this evaluation. The first approach involved demonstrating a statistically significant decrease in variability, with 95% confidence using the Levene's test, between ISM and conventional grab samples.

We compared the smaller ISM variances with the grab variances to determine whether they were significantly different with at least 95% confidence. The evaluation indicated that the ISM approach generally resulted in better measurement precision for all three of the demonstration sites; the ISM approach generally resulted in smaller variances though the target level of confidence (95%) was not met for all of the metals and DUs. We observed the largest differences in the variance for Pb, which is usually the primary contaminant of concern for small-arms ranges. Figure 43 illustrates the large reductions for the Pb variances for the natural-logarithm-transformed ISM (n = 15) replicates and the (n = 48) grab replicates from the Fort Wainwright DU. The Levene's test indicates the variance of the set of incremental samples (denoted as "ISM") is significantly smaller than the variance of the set of grab samples (denoted by "Discrete") with well over 95% confidence (as the "P-value" is much smaller than 0.05). The Levene's test was not able to detect significant differences between the grab and ISM variances for Cu and Zn with at least 95% confidence, but the square ranks test for the variances detected significant differences with at least 95% confidence for Pb and Cu (the level of confidence was greater than 99% for Pb, 99% for Cu, but only 85% for Zn). Although the hypothesis tests did not detect significant differences between the variances at the target level of confidence, the ISM approach seems to result in better precision than conventional grab sampling. The standard deviation for the set of grabs (22 mg/kg) is over three times larger than the ISM standard deviation (7 mg/kg).

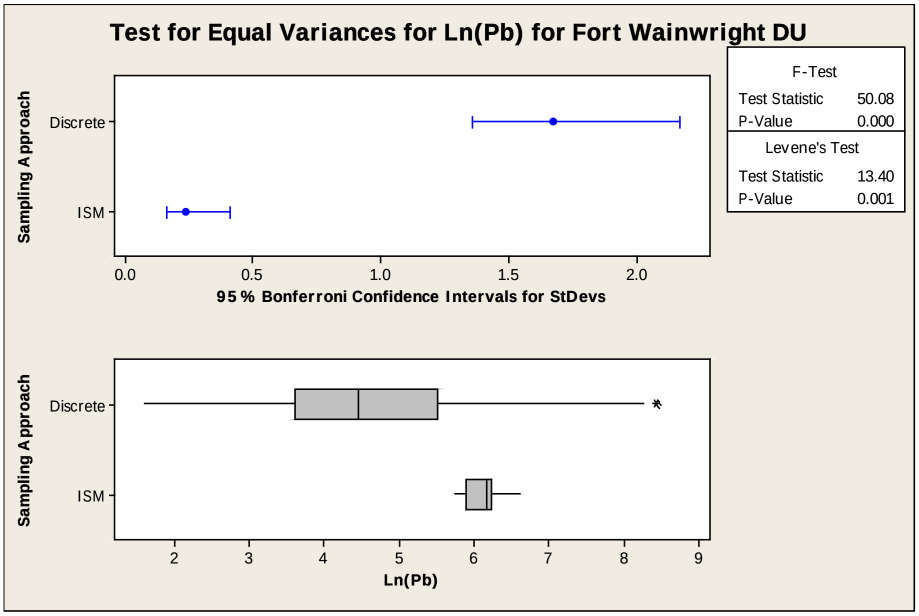


Figure 43. Test for equal variances for lead at the Fort Wainwright Decision Unit.

As shown in the Zn boxplots below (Fig. 44), the grab replicates also exhibit a much larger number of outliers and a greater skewness than ISM replicates. Values that exceeded the upper or lower quartiles by 1.5 × IQR (Interquartile Range) or more were identified as "outliers," consistent with conventional terminology and plotting procedures for boxplots.

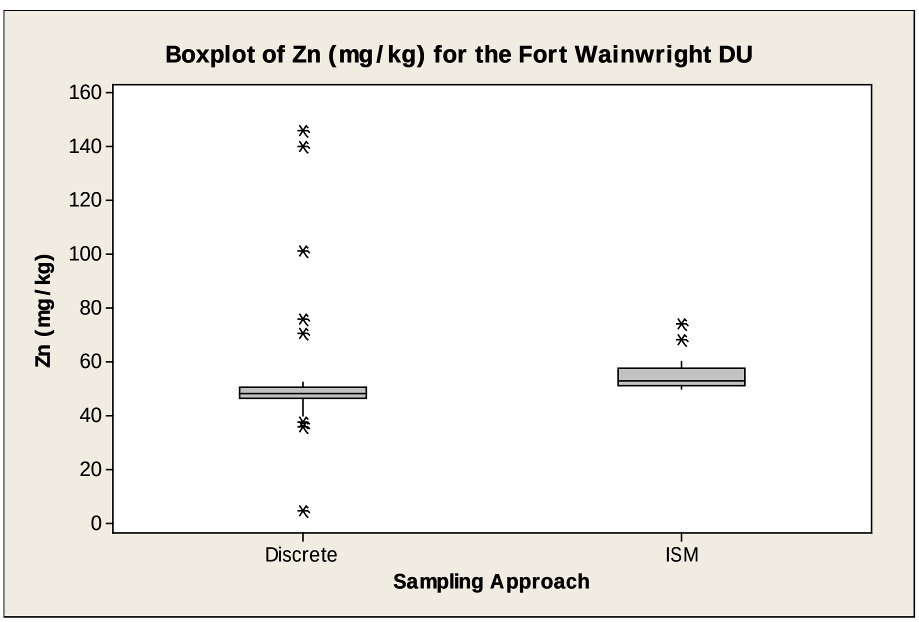


Figure 44. Boxplot of zinc results for the Fort Wainwright Decision Unit.

A second test involved calculating the RSD for each population (Table 34). Again, for all three sites, the RSDs for the ISM samples were significantly lower than for the conventional grab samples. However, there were situations where the performance objective of less than 30% RSD was not met for some metals with ISM. As shown at Fort Eustis and Fort Wainwright, an ISM sample with a larger number of increments and a greater mass yielded lower RSDs (Table 34). In those situations when the performance metric of an RSD less than 30% was not met, the target would have likely been achievable by re-sampling and collecting an ISM sample with a greater number of increments, by using a larger sampling tool to increase the recovered mass, by increasing the digestion mass, or by increasing the number of subsampling increments to build the digestion aliquot. This leads to the observation that when the degree of expected analyte heterogeneity is unknown, the sampler should err on the conservative side by collecting a sample from a DU with a larger number of increments or with a greater mass. The other approach is to select a DU with a smaller area that will thus increase the number of increments per DU area or mass of sample per DU area. Overall, sample reproducibility precision was improved with the collection of ISM samples as compared to conventional grab samples. Clausen et al. (2012b) previously demonstrated the laboratory subsampling precision during the technology development of this project.

Table 34. Comparison of RSD values for the analytes of interest (copper, lead, antimony, zinc) for ISM and for conventional grab samples at the three demonstration sites.

	Kimama TS	Fort Eustis[1]	Fort Wainwright[2]
	Incremental Sampling Methodology		
Mean mass (g)	881	1112/1485	2403/1208/1237
Number of samples	15	15/15	15/15/15
Copper RSD (%)	53	104/44	64/52/125
Lead RSD (%)	18	72/30	24/56/58
Antimony RSD (%)	ND	500/60	ND/ND/ND
Zinc RSD (%)	23	5/4	8/17/20
	Conventional Grab Samples		
Mean mass (g)	100	78.8/69.6	159
Number of samples	30	33/12	48
Copper RSD (%)	66	298/224	218
Lead RSD (%)	334	350/247	226
Antimony RSD (%)	172	219/295	97
Zinc RSD (%)	15	23/27	69

Green = less than 30% RSD, Yellow = about 30% RSD, Red = greater than 30% RSD

RSD—relative standard deviation

ND—not detected

[1] Entire berm/right side of berm.

[2] Entire berm/ left side Berm 11/right side Berm 11.

6.2 Bias evaluation

As shown in Section 5.6.2, the MB and LCS indicate no bias in sample results. Although the glass blank samples analyzed indicate some increase in Al, Cr, Fe, and Mn as a result of milling with the puck mill, none of the analytes of interest (Cu, Pb, Sb, or Zn) increased significantly. Therefore, there is no cross-contamination from the puck mill into the samples for metals of interest (Cu, Pb, Sb, and Zn).

6.3 Performance comparison

As demonstrated in Clausen et al. (2012b), improved accuracy of the “true” mean is a product of ISM whereas conventional grab samples yield inaccurate estimates of the mean for soils with metallic residues. In addition, improved precision is a product of ISM. As shown, in this demonstration, to-

tal sample errors as measured by RSD are often several hundred percent for conventional grab samples whereas RSDs for ISM samples are typically less than 30% for soils containing metallic residues.

Improved accuracy or precision may not be necessary when the soil metal concentration is well above or well below a regulatory action level or some other criteria for comparison. However, as observed from this demonstration in the case of Pb, different decisions are likely to be made whether conventional grab or ISM samples are collected. For example, if considering the berm at Fort Wainwright, the ISM mean Pb level for the entire berm was 453 mg/kg. If this site was a candidate for remediation, the typical action level used is a value of 400 mg/kg. Thus, the ISM data would suggest action is necessary for this DU. If all 48 grab sample results are considered, the mean value is 432 mg/kg which would also suggest an action is necessary for the DU. However, in most investigations, the collection of 48 grab samples would be considered unrealistic and unaffordable. Discussions with a variety of environmental consultants familiar with small-arms ranges suggest typically 7 to 15 grab samples would be collected. Using a random number generator, we randomly selected seven grid grab samples from the 48 grids (Fig. 42) and determined the maximum value. The typical approach for risk assessment is to compare a maximum value against the regulatory value or to calculate the upper confidence limit (UCL) from the mean and to compare the derived UCL to the regulatory value. For this exercise, we determined the maximum value for the seven grab samples 30 times. The maximum values ranged from 114 to 4500 mg/kg with the mean and median maximum values being 2301 and 2271 mg/kg. The variance for these 30 simulations was 3,046,988 mg/kg. Thirteen percent of the time, the maximum value would be less than 400 mg/kg and 87% of the time it would be greater than 400 mg/kg. Based on this simulation, 13% of the time the maximum Pb level would be below the action level of 400 mg/kg based on grab sampling, thus suggesting no action is required. However, with ISM, one is assured of making the correct decision each time for an action because the minimum ISM Pb value for the 15 replicates was 1995 mg/kg.

When sample sizes are sufficiently large, grab and ISM samples should yield similar estimates of the population mean. However, in general, the ISM results exhibit a higher mean concentration than grab sample results. This situation occurred in 60% of the sample results for the three demon-

stration sites and one experimental site for the metals of interest (Cu, Pb, Sb, and Zn). In instances where the ISM mean was less than the grab sample mean, the data exhibited greater variability than desired. In practice, owing to cost considerations, a sufficient number of grab samples to adequately characterize variability are seldom collected, potentially resulting in highly censored data and lower estimates of the mean. In addition, when the degree of heterogeneity is large, one will need larger sample sizes for grab samples relative to ISM samples to detect differences of the same magnitude. In the cases where the ISM mean was lower than the grab sample mean, it seems likely that ISM sample precision and accuracy could have been improved by taking all or some of the following steps:

1. Increasing the number of increments collected from the DU.
2. Increasing the sample mass collected from the DU.
3. Increasing the number of subsampling increments to build the digestion aliquot.
4. Increasing the digestion mass.

One of the advantages of ISM is the ability to assess the total sample error or error associated with specific steps of the ISM process, allowing for the establishment of performance criteria. If the criteria are not met initially, the ISM process can be altered to meet one’s sample quality objectives. Other practical ISM advantages include reducing data censoring (which results in information loss) and enabling parametric statistical methods with more power than the corresponding non-parametric methods.

In terms of assessing performance by cost, we evaluated each stage of the sampling activity and the laboratory processing step for the time to perform the task for both the ISM and conventional grab samples at each of the three sites. For the field sampling activities, we considered seven variables for surface soil samples:

1. Mobilization preparation time.
2. Shipping of field equipment to the site.
3. Surveying and flagging in the field.
4. Sampling.
5. Labeling samples.
6. Demobilization.
7. Shipping of samples and equipment to the laboratory.

Mobilization, shipping equipment to the field, and demobilization costs are essentially the same. The remaining field activities take twice as long with ISM versus conventional grab sampling on a per sample basis. Laboratory preparation procedures assessed for the soil sample were (1) air drying, (2) sieving, (3) milling, and (4) subsampling to prepare the digestion aliquot. With the conventional grab sampling approach, the collection of a 1- to 2-g aliquot from the top of the jar takes minimal time, thus there are no sample preparation costs. Based on our experience at CRREL, the laboratory preparation time per sample is roughly 30 min of labor. There is essentially no difference between analyses for a conventional grab sample versus ISM. Table 35 shows the breakdown of costs, based on a field technician and laboratory technician rate of $50/hr, by field, sample preparation, and analysis activity. On a per sample basis, the cost of ISM is approximately 55% to 65% higher than conventional grab sampling. However, a cost savings materializes when one considers the number of samples. For a typical small-arms range DU, three replicate samples would be collected versus 7 to 15 conventional grab samples for the same DU. Thus, the total per sample cost is 1 to 3 times (5% to 65%) higher with the conventional grab sampling method versus ISM. Therefore, ISM met our performance criteria of at least a 20% reduction in sample cost.

Table 35. Comparison of costs between ISM and conventional grab sampling on a per sample and total cost basis based on demonstrations at Kimama Training Site, Fort Eustis, and Fort Wainwright.

	Per Sample Costs ($)		Total Project Costs ($)		Total Project Costs ($)	
Activity	ISM	Grab	ISM[1]	Grab[2]	ISM[1]	Grab[3]
Field	35–50	10–15	105–150	70–105	105–150	150–225
Laboratory Preparation	40–60	0–10	120–180	0–70	120–180	0–150
Analysis	225–275	125–135	675–825	875–945	675–825	1875–2025
Total	300–385	135–160	900–1155	945–1120	900–1155	2025–2400

[1] Based on collection of 3 replicates.

[2] Based on the collection of 7 grab samples.

[3] Based on the collection of 15 grab samples.

It should be noted that the number of grab samples and ISM replicates collected are greater than the typical site investigation, so the precision of the demonstration grab results is likely to be greater than typical field studies. The purpose for collecting a large number of grab samples and ISM replicates was to be able to statistically analyze the data. A sampling

choice between the two methods, constrained by the same cost budget, might generally favor ISM.

6.4 Implementability

Discussions with field personal indicate that ISM is readily implemental. Implementability was a qualitative ISM performance objective for this demonstration project. ISM requires no special field equipment beyond what one typically uses for collection of conventional grab surface soil samples although it is recommended that a sample corer device be used so that a cylindrical soil sample is collected to adhere to Gy's theory (Gy 1999, 1992). Sometimes environmental sampling is performed with metal scoops rather than a cylindrical coring device, and the use of scoops should be discouraged.

The additional laboratory processing steps outlined with ISM are more involved than for conventional grab sample processing. The larger sample volume and the need for sample drying, sieving, and milling necessitate a dedicated room at the laboratory for sample processing. This may be problematic for some of the smaller commercial environmental laboratories, but discussions with the larger firms indicate that this is not an impediment to implementability. A number of the larger commercial environmental laboratories have such dedicated sample processing facilities.

Equipment for milling of the soil samples is a potential limiter to the implementability of ISM. Few commercial environmental laboratories have a puck mill, puck and ring mill, or roller/ball mill. Although a puck mill or puck and ring mill is expensive, a roller/ball mill is more affordable. If one is interested in the potential cross-contamination from metallic components of the puck mill or puck and ring mill, agate bowls and pucks are available. However, currently available agate bowls and pucks are small (i.e., they generally hold less than 600 g of material), thus requiring multiple milling operations to process the entire lot of a single sample. Furthermore, agate milling equipment is expensive compared to steel. One lower cost alternative is the roller/ball mill, which has Teflon lined cans and, when combined with ceramic chips, provides an acceptable alternative to the puck mill and puck and ring mills as demonstrated by Clausen et al. (2012b).

The other laboratory changes involve subsampling to prepare the digestion aliquot; digesting an aliquot minimum mass of 2 g; using a consistent acid to soil ratio; and adding an alternative acid solutions for some metals, such as antimony and tungsten, that have poor recoveries with the standard acid digestion procedure of Method 3050B. Discussions with a number of commercial environmental laboratories indicate that all of these proposed changes are readily implementable. Since these changes are more involved than the conventional approach, a higher per analysis cost would result.

7 Cost Assessment

The costs associated with field-sampling activities include travel, related lodging and meals, labor, and the shipment of samples off site. Unique to the costs associated with sampling activities on military training ranges is the need to acquire the services of explosive ordnance disposal (EOD) personnel or UXO technicians. However, we anticipate the expenses associated with gaining site assess, engaging EOD support, travel, and labor to be equivalent for grab and ISM. Additionally, in the case of small-arms ranges, an EOD escort is not needed because UXO presence is unlikely. The major cost differences between ISM and those methods currently in practice thus arise predominately from the handling and processing of larger environmental samples than grab samples. However, this cost increase is greatly offset by the need for fewer samples to adequately characterize a DU. The cost differential between conventional grab samples and ISM is quantifiable. However, the cost of making a wrong decision is not easily quantifiable. The potential cost of implementing a remedial remedy when it is not necessary could be quite large, ranging from tens of thousands to tens of millions of dollars. Implementing ISM will result in lower false positive rate, which is associated with fewer unnecessary remedial actions. Conversely, our modified method, Method 3050C, has a more reliable detection rate, thus avoiding false negatives.

7.1 Cost model

To aid in our cost analysis, the team collected and tracked in an Excel spreadsheet the labor hours in all phases or the actual costs of the field demonstration (preparing the site, locating the samples with GPS, labeling the samples, collecting the samples, shipping samples, etc.) (Table 36). In addition, we tracked the cost or the labor hours to process the samples and to analyze them in the laboratory. We ascertained labor categories and labor rates so that labor hours could be converted to actual costs. Because the actual number of samples collected for this demonstration was greater than a typically project, we took the following approach. For ISM, we compared 3 replicate samples from a single DU against a typical number of conventional grab samples for the same. Because the number of grab samples collected varies by objective, analyte of concern, desires of the interested stakeholders, etc., we considered two scenarios: 7 and 15 grab sam-

ples. We based this range on discussions with individuals involved with sampling MMRP sites using conventional grab sampling techniques.

Table 36 Comparison of labor hours[1] or costs by cost element between ISM and conventional grab sampling on a per sample and total cost basis based on demonstrations at Kimama Training Site, Fort Eustis, and Fort Wainwright.

		Fort Wainwright				Fort Eustis				Kimama Training Site			
		ISM	Grab	ISM	Grab	ISM	Grab	ISM	Grab	ISM	Grab	ISM	Grab
Stage	Activity	Per Sample		Total Project		Per Sample		Total Project		Per Sample		Total Project	
Mobilization	Preparation	=	=	=	=	=	=	=	=	=	=	=	=
	Expendables	$8.62	$1.29	$129.35	$61.92	$8.62	$0.89	$129.35	$42.57	$8.62	$1.29	$129.35	$38.70
	Shipping Field Equipment	=	=	=	=	=	=	=	=	=	=	=	=
Field	Surveying/ Flagging	1	1	16	53	2	1	30	45	1	2	8	54
	Sampling	12	2	90	37	20	4	150	60	20	3	150	45
	Decontamination	0	2	0	96	0	5	0	165	0	5	0	150
	Labeling	2	2	35	113	1	1	15	33	1	1	18	36
	Demobilization	=	=	=	=	=	=	=	=	=	=	=	=
	Shipping Samples	$25.27	$2.46	$379.00	$118.00	$7.54	$2.59	$113.14	$85.47	$22.27	$3.67	$334.00	$110.00
	Shipping Field Equipment	=	=	=	=	=	=	=	=	=	=	=	=
Laboratory	Air Drying Prep	2	0	30	0	2	0	30	0	2	0	30	0
	Sieving	2	0	30	0	2	0	30	0	2	0	30	0
	Milling	5	0	75	0	5	0	75	0	5	0	75	0
	Cleaning Milling Equipment	10	0	150	0	10	0	150	0	10	0	150	0
	Sub-Sampling	10	0	150	0	10	0	150	0	10	0	150	0
	QA/QC	$26.67	$33.33	$400.00	$1,600.00	$26.67	$26.67	$400.00	$800.00	$26.67	$26.67	$400.00	$800.00
	Laboratory Supplies	<	>	<	>	<	>	<	>	<	>	<	>
	Analysis	$225.00	$100.00	$3,375.00	$4,800.00	$225.00	$100.00	$3,375.00	$3,300.00	$225.00	$100.00	$3,375.00	$3,000.00

[1] Units are hours unless denoted by $.

= Indicates equivalent cost; > or < denotes a minor lower or greater cost not tracked.

We also calculated the costs based on our labor at CRREL and EL for sample preparation and analysis and obtained actual costs from several commercial environmental laboratories (Table 37). We used a labor rate of $50/hr for converting labor into dollars. A typical soil digestion and target analyte list (TAL) analysis of 13–18 metals cost $100 per sample. If ISM sample preparation (air drying, sieving, subsampling) including milling is required, this adds $125 per sample. Use of ISM sample preparation without milling adds $75 per sample.

Table 37. Comparison of costs for ISM and for conventional grab sampling on a per sample and total cost basis based on demonstrations at Kimama Training Site, Fort Eustis, and Fort Wainwright.

		Fort Wainwright				Fort Eustis				Kimama Training Site			
		ISM	Grab	ISM	Grab	ISM	Grab	ISM	Grab	ISM	Grab	ISM	Grab
Stage	Activity	Per Sample		Total Project		Per Sample		Total Project		Per Sample		Total Project	
Mobilization	Preparation	=	=	=	=	=	=	=	=	=	=	=	=
	Expendables	$9	$1	$129	$62	$9	$1	$129	$43	$9	$1	$129	$39
	Shipping Field Equipment	=	=	=	=	=	=	=	=	=	=	=	=
Field	Surveying/ Flagging	$1	$0.92	$13	$44	$2	$1	$30	$45	$0	$2	$7	$45
	Sampling	$10	$1	$75	$31	$17	$4	$150	$60	$17	$3	$125	$38
	Decontamination	$0	$2	$0	$80	$0	$5	$0	$165	$0	$4	$0	$125
	Labeling	$2	$2	$29	$94	$1	$1	$15	$33	$1	$1	$15	$30
	Demobilization	=	=	=	=	=	=	=	=	=	=	=	=
	Shipping Samples	$25	$2	$379	$118	$8	$3	$113	$85	$22	$4	$334	$110
	Shipping Field Equipment	=	=	=	=	=	=	=	=	=	=	=	=
Laboratory	Air Drying Prep	$2	$0	$25	$0	$2	$0	$25	$0	$2	$0	$25	$0
	Sieving	$2	$0	$25	$0	$2	$0	$25	$0	$2	$0	$25	$0
	Milling	$4	$0	$63	$0	$4	$0	$62	$0	$4	$0	$63	$0
	Cleaning Milling Equipment	$8	$0	$125	$0	$8	$0	$125	$0	$8	$0	$125	$0
	Sub-Sampling	$8	$0	$125	$0	$8	$0	$125	$0	$8	$0	$125	$0
	QA/QC	$27	$33	$400	$1,600	$27	$27	$400	$800	$27	$27	$400	$800
	Laboratory Supplies	<	>	<	>	<	>	<	>	<	>	<	>
	Analysis	$225	$100	$3,375	$4,800	$225	$100	$3,375	$3,300	$225	$100	$3,375	$3,000
	Total	**$323**	**$143**	**$4,763**	**$6,829**	**$311**	**$141**	**$4,574**	**$4,531**	**$325**	**$141**	**$4,748**	**$4,186**

From a statistical basis (e.g., the Central Limit Theorem), n incremental samples, each prepared from k increments, will produce data that is roughly of similar quality for the estimation of the population mean of the DU as $n \times k$ discrete samples. On the basis of this simplistic model, the cost of sampling n ISM samples of k incremental in the field will be no greater than $n \times k$ discrete samples. The cost of the former would be expected to be less than that of the latter because ISM would entail the use of fewer sample containers and less labeling and documentation. Even if comparable field sampling costs are estimated for the grab and ISM samples, the ISM approach will result in a cost savings owing to the smaller number of laboratory analyses required.

Similarly, if each grab sample is assumed to weigh on the average 150 g and each ISM weighs 1500 g but $n \times k$ grab samples produce the same quality of data as n ISM, it follows that the total weight of the grab and ISM samples that need to be shipped is 150 g $\times\, n \times k$ and 1500 g $\times\, n$, respectively. Therefore, the cost of shipping n ISM samples should be about one tenth the cost of shipping $n \times k$ grab samples. The cost of sample disposal would be similarly reduced.

The ISM approach will result in a cost savings for the determinative (instrumental) portion of the analytical method by a factor of k. However, the additional sample preparation steps needed for the ISM approach increas-

es the total per-sample laboratory analytical cost for each metal analysis (which includes the cost of sample preparation and instrumental analysis). Additional sample preparation is required for both the environmental samples and the batch QC samples, such as MBs and LCSs. Owing to the sample mass that needs to be processed (e.g., milled), the preparation of LCS for the ISM approach is more costly than that for the grab sampling approach. We conservatively estimate that the ISM approach will increase the total laboratory analysis cost per sample by a factor of no more than two. The sample preparation procedures, which entail drying sieving and milling, are similar to those used for Method 8330B, which increased the cost of these analyses by about $150 (Hewitt et al., 2009), approximately doubling the per sample cost of an explosive analysis. Similarly, an LCS from ERA for the analysis of metals using the ISM approach is similar to that for an LCS for the analysis of the ISM method for explosives using EPA Method 8330B. As the per sample cost for the analysis of a soil sample by a commercial environmental testing laboratory for Target Analyte Metal (TAL) by Method 3050B/6010B is about $100, it is reasonable to conclude that the per sample cost for the ISM approach will increase by no more than a factor of two. As $k = 100$ for this effort, the total laboratory portion for the ISM laboratory analyses should be smaller than the total laboratory cost for discrete sample analyses by a factor of $k/2 = 50$.

7.2 Cost drivers

The main cost drivers that should be considered in selecting the technology for future implementation include the number of DU sampled, the number of replicates collected, and the mass of the sample. The key site-specific characteristic that will significantly impact cost is the degree of contaminant heterogeneity expected. If an aqueous metal release occurred, then contaminant heterogeneity is likely to be low; and milling of the sample may not be necessary as adequate precision can likely be achieved without this sample preparation step. However, if metal residues were released into the environment, then sample heterogeneity is likely to be high; and milling will be required. Milling adds approximately $100 to the per sample cost (Table 35) although the total project costs are likely to be lower depending upon the number of grab samples that would have been collected.

Sample theory indicates that cylindrical cores should be collected. The use of scoop-type samplers, therefore, is discouraged. A device such as CMIST (Walsh 2009), which collects a cylindrical core, is desired; and the cost investment is modest and can be recouped through repetitive use of the sampler. The CMIST device works well in soft unconsolidated soils.

Another low cost alternative for unconsolidated soils includes the use of 50 cc syringes with the tip cut off that can then be pushed into the ground to collect a core, and the plunger is used to eject the soil. A single syringe can be used for multiple increments from the same DU. There should be no impact on ISM implementation based on these cost drivers. The biggest cost driver is the purchase of milling equipment by the environmental laboratory and the setup of a dedicated sample processing room. At present, a limited number of commercial laboratories have made the investment in milling equipment. However, as the demand for milling increases as a result of changes to the regulatory requirements, more laboratories are likely to add this to their service capability.

7.3 Cost analysis

For our cost analysis, we considered the need to sample a single DU using triplicate ISM samples as compared to the collection of 7 or 15 conventional grab samples (Table 35). The DU consisted of a small-arms range berm 100 m long by 9 m high. The sample depth was 5 cm, and we assumed the standard metal TAL. We also assumed a one-time sampling event. We assumed a field sampling crew of 2 individuals although, for the demonstration, we used either 3 or 4 individuals to speed up the sampling process.

Sample preparation costs were nearly equivalent for ISM and grab samples although it has been our experience that the same degree of planning used for ISM is not afforded to grab samples. However, our assumption was that the same degree of planning and organization of field equipment would occur for both sampling approaches. The expendables used in the demonstration were slightly different and account for a slight cost difference. In the case of grab sampling, the samples were collected in 4-oz, amber-glass, wide-mouth jars, which is the norm in environmental sampling. The ISM samples were collected in 15 × 15-in., 3-mm plastic bags and secured with a sample label and a twist tie. We used this type of container to accommodate the larger volume of soil collected. It should be noted that

similar sample collection containers could be used for both sampling approaches. Since the same field equipment is used, the mobilization and shipping costs are largely equivalent.

In the field, each individual grab sample is typically surveyed because it is a unique sampling location. In contrast, with ISM, the DU is the unique location; so only a single corner of the DU needs to be surveyed if the DU is easily demarcated on a map or aerial photograph. If the boundaries are less clear, then each corner of the DU can be surveyed. Individual increment sample locations do not need to be surveyed. The sampling activity is essentially the same although, with ISM, multiple increments are collected and combined to form a single sample. Cylindrical cores need to be collected with ISM to satisfy sample theory. In the demonstration, we used the CMIST to collect both ISM and grab samples. Decontamination of the sampling tool used for ISM is not needed as long as the samples are being collected from within the same DU. While this is true of replicate samples collected from the same DU, cleaning of the sample tool between replicates is a good management practice and should help to ensure the statistical independence of the replicates. In contrast, each grab sample is unique and, thus, requires either disposable sample tools or decontamination between samples. Our decontamination procedure consisted of an acetone rinse followed by a triplicate deionized water rinse. Our cost analysis does not include disposal of rinse of water. However, recovery of this waste water would add slightly to the per sample and total project costs for grab sampling.

Because there are typically more samples to label using the grab approach, more time is required for this activity. Field demobilization and shipping of equipment costs are essentially equivalent as discussed earlier in regards to mobilization activities. There is a difference in sample shipping costs between the two approaches. Although fewer soil samples are collected with ISM, the mass of material collected is 5 to 10 times larger than a grab sample. Thus, whether ISM or grab samples come out on the favorable end of the cost equation depends on the number of samples collected with each method. The conventional grab sampling approach typically does not involve sample preparation. In some cases, a portion of the soil may be air-dried and given a couple turns in a mortar and pestle. However, discussions with commercial environmental laboratories indicate that this is not typical unless the client specifies this activity. The typical ap-

proach is for the laboratory to open the 4-oz jar and scoop 0.5 to 2 g of material off the top to be used for digestion. As discussed previously, ISM involves air-drying, sieving, milling, and subsampling.

Because more grab samples are collected than with ISM, the associated QA/QC costs are higher. The QA/QC analysis includes MS, MSD, laboratory duplicates, and process blanks. This also holds true for the analysis cost, which is the same for both types of samples; but more samples are collected and analyzed with the grab approach.

Our cost analysis indicates field sampling using ISM is $20–$40 higher per sample than conventional grab sampling (Table 35). This is largely a function of the greater amount of time needed to collect the ISM sample (i.e., the collection of multiple increments). Similarly, laboratory preparation costs run $40–$60 higher with ISM; and analysis, which includes QA/QC, is double the grab sample cost. This is largely a function of ISM requiring processing of the sample whereas conventional grab sampling typically does not involve sample preparation activities. Therefore, on a per sample basis, the cost of ISM is approximately 55% to 65% higher than conventional grab sampling. The per sample cost for sampling soil with metal residues with ISM ranges from $300–$385.

However, the total project cost with ISM is lower than the conventional grab method. This is due to more samples typically collected with grab sampling. For a typical small-arms range DU, three replicate ISM samples would be collected versus 7 to 15 conventional grab samples for the same DU. Therefore, total project costs are to 5% to 50% lower with ISM. The cost savings become greater as the number of samples increases. The reduction of costs with ISM is primarily a function of the fewer number of samples needed to adequately characterize an area.

8 Implementation Issues

The implementation of USEPA Method 8330B (USEPA 2006) for energetics has resulted in increased application of ISM and the recognition that this approach may be applicable to other analytes in addition to energetics. The Interstate Technology Regulatory Council (ITRC 2012) recently published a guidance document that discussed in great technical detail the theory and application of ISM. The DoD and Army, other government agencies, federal and state regulators, environmental consultants, and commercial laboratories have increasingly discussed the application of ISM to metals. This sampling strategy is now mandated by the states of Alaska (Alaska 2009) and Hawaii (Hawaii 2008) for all surface soil sampling situations and analytes. Presently, the authors of this document are working with the USEPA to modify and update Method 3050B to accommodate ISM with the new Method referred to as Method 3050C. This includes changes to the laboratory sample preparation procedures, including milling of the samples, and the addition of an Appendix discussing the application of ISM in the field. Much of the Appendix language is similar to the additions made and promulgated in USEPA Method 8330B. The US Army Corp of Engineer Environmental and Munitions Center of Expertise and DoD are considering changes to existing guidance incorporating ISM.

The field demonstrations conducted at the three test sites indicate ISM is readily implementable. No special field equipment is required beyond what is typically used for collection of conventional grab surface soil samples. However, it is recommended that a sample corer device be used so that cylindrical soil samples are collected, rather than scoops, to adhere to Gy's theory (Gy 1999, 1992). Environmental sampling performed with metal scoops should be discouraged since they do not provide a representative sample (ITRC 2012).

The additional laboratory processing steps outlined with ISM are more involved than what has been used for conventional grab sample processing. The larger sample volume and the need for sample drying, sieving, and milling necessitate a dedicated room at the laboratory for sample processing. This may be problematic for some of the smaller commercial environmental laboratories, but discussions with the larger firms indicate this

is not an impediment to implementability. A number of the larger commercial environmental laboratories already have such dedicated sample processing facilities.

Equipment for milling of the soil samples is a potential limiter to the implementability of ISM, see Section 6.4. The other laboratory changes involve subsampling to prepare the digestion aliquot; digesting an aliquot minimum mass of 52 g; using a consistent acid to soil ratio; and adding alternative acid solutions for some metals, such as antimony and tungsten, that have poor recoveries with the standard acid digestion procedure of Method 3050B. Discussions with a number of commercial environmental laboratories indicate all of these proposed changes are readily implementable but will result in larger unit costs for the metal analyses.

However, there remains resistance to adopting ISM; because many of the concepts are new, the perception is that ISM cannot provide adequate characterization information and that the costs for ISM are higher than for conventional grab sampling. ITRC (2012) identified and discussed this issue of ISM acceptance.

References

Alaska. 2009. *Draft Guidance on MULTI INCREMENT Soil Sampling*. Anchorage, Alaska: Alaska Department of Environmental Conservation, Division of Spill Preventions and Response, Contaminated Sites Program.

Ampleman, G., S. Thiboutot, J. Lewis, A. Marois, S. Jean, A. Gagnon, M. Brouchard, R. Martel, R. Lefebvre, C. Gauthier, J. M. Ballard, T. A. Ranney, and T. F. Jenkins. 2003a. *Evaluation of the Impacts of Live Fire Training at CFB Shilo.* DRDC-Valcartier-TR-2003-066. Quebec, Canada: Defence Research Development Canada—Valcartier.

Ampleman, G., S. Thiboutot, J. Lewis, A. Marois, S. Jean, A. Gagnon, M. Brouchard, T. Jenkins, A. Hewitt, J. C. Pennington, and T. A. Ranney. 2003b. *Evaluation of the Contamination by Explosives in Soils, Biomass and Surface Water at Cold Lake Air Weapons Range (CLAWR), Alberta, Phase 1 Report.* DRDC-Valcartier-TR-2003-208-Annex. Quebec, Canada: Defence Research Development Canada—Valcartier.

ASTM. 2003a. *Standard Guide for Laboratory Subsampling of Media Related to Waste Management Activities.* ASTM D6323-98. West Conshohocken, PA: American Society for Testing and Materials.

ASTM. 2003b. *Annual Book of ASTM Standards*. Philadelphia, PA: American Society for Testing and Materials.

Clausen, J. L., J. Robb, D. Curry, and N. Korte. 2004. A case study of contaminants on military ranges: Camp Edwards, Massachusetts, USA. *Environmental Pollution* 129:13–21.

Clausen, J., and N. Korte. 2009a. The distribution of metals in soils and pore water at three U.S. military training facilities. *Soil and Sediment Contamination Journal: An International Journal* 18(5):546–563.

Clausen, J. L. and N. Korte. 2009b. Environmental fate of tungsten from military use. *The Science of the Total Environment* 407(8):2887–2893.

Clausen, J., S. Taylor, S. Larson, A. Bednar, M. Ketterer, C. Griggs, D. Lambert, A. Hewitt, C. Ramsey, S. Bigl, R. Bailey, and N. Perron. 2007. *Fate and Transport of Tungsten at Camp Edwards Small Arms Ranges.* ERDC/CRREL TR-07-05. Hanover, NH: US Army Engineer Research and Development Center.

Clausen, J. L., A. Bednar, D. Lambert, R. Bailey, M. Kuhlbrush, S. Taylor, and S. Bigl. 2010. *Phase II Tungsten Fate-and-Transport Study for Camp Edwards*. ERDC/CRREL TR-10-3. Hanover, NH: US Army Engineer Research and Development Center.

Clausen, J. L., J. Richardson, N. Korte, G. Gooch, T. Hall, N. Perron, E. Butterfield, M. Walsh, and S. Taylor. 2012a. *Metal Residue Deposition from Military Pyrotechnic Devices and Field Sampling Guidance*. ADA562327. Prepared for US Army Environmental Command, Fort Sam Houston, TX. Hanover, NH: US Army Engineer Research and Development Center. http://handle.dtic.mil/100.2/ADA562327.

Clausen, J. L., T. Georgian, J. Richardson, A. Bednar, N. Perron, L. Penfold, D. Anderson, G. Gooch, T. Hall, and E. Butterfield. 2012b. *Evaluation of Sampling and Sample Preparation Modifications for Soil Containing Metal Residues*. ERDC TR-12-1. Hanover, NH: US Army Engineer Research and Development Center. http://acwc.sdp.sirsi.net/client/search/asset:asset?t:ac=$N/1006020.

Collins, C. M. 1990. *Morphometric analyses of recent channel changes on the Tanana River in the vicinity of Fairbanks, Alaska*. CRREL Report 90-4. Fairbanks, AK: Cold Regions Research and Engineering Laboratory.

DoD. 2005. *Operational Range Assessments*. DoD Instruction 4715.14. Washington, DC: Department of Defense. http://www.dtic.mil/whs/directives/corres/pdf/471514p.pdf.

DoD. 2007. *Environmental and Explosives Safety Management on Operational Ranges Within the United States*. DoD Directive 4715.11. Washington, DC: Department of Defense. http://www.dtic.mil/whs/directives/corres/pdf/471511p.pdf.

DoD. 2013. *Data Quality Systems Manual (QSM) for Environmental Laboratories, Version 5.0*. Washington, DC: Department of Defense. http://www.denix.osd.mil/edqw/upload/QSM-Version-5-0-FINAL.pdf.

Duncan, A. J. 1962. Bulk sampling: Problems and lines of attack. *Technometrics* 4:319–344.

Elder, R. S., W. O. Thompson, and R. H. Myers. 1980. Properties of composite sampling procedures. *Technometrics* 22:179–186.

Felt, D. R., A. J. Bednar, T. Georgian. 2008. The effects of grinding methods on metals concentrations in soil. *Talanta* 77(1):380–387.

FPM. 2009. *Final Site Inspection Report—Kimama Training Site, Rupert, Idaho.* Rome, NY: FPM Group, Ltd.

FPM. 2010. *Project Management Plan Military Munitions Response Program Remedial Investigation/Feasibility Study Training Area 3 MRS (KTS-003-R-01)*. Rome, NY: FPM Group, Ltd.

Gerlach, R. W., and J. M. Nocerino. 2003. *Guidance for Obtaining Representative Laboratory Analytical Subsamples from Particulate Laboratory Samples.* Washington, DC: US Environmental Protection Agency. EPA/600/R-03/027.

Gy, P. 1992. *Sampling of Particulate Materials Theory and Practice*. New York, NY: Elsevier Scientific Publishing Company.

Gy, P. 1999. *Sampling for Analytical Purposes*. New York, NY: John Wiley and Sons.

Hawaii. 2008. Section 4, Soil Sample Collection Approaches. In *Interim Final Technical Guidance Manual for the Implementation of the Hawaii State Contingency Plan*. Hawaii Department of Health, Office of Hazard Evaluation and Emergency Response. http://www.hawaiidoh.org/.

Hewitt, A. D., and J. H. Cragin. 1991. Comment on "Acid digestion for sediments, sludges, soils, and solid wastes. A proposed alternative to EPA SW-846 Method 3050." *Environmental Science and Technology* 25:985–986.

Hewitt, A. D., and J. H. Cragin. 1992. Comment on "A study of the linear ranges of several acid digestion procedures." *Environmental Science and Technology* 26:1848–1849.

Hewitt, A. D., and M. E. Walsh. 2003. *On-site homogenization and sub sampling of surface samples for analysis of explosives*. ERDC/CRREL TR 03-14. Hanover, NH: US Army Engineer Research and Development Center.

Hewitt, A. D., T. F. Jenkins, C. A. Ramsey, K. L. Bjella, T. A. Ranney, and N. M. Perron. 2005. *Estimating energetic residue loading on military artillery ranges: Large decision units*. ERDC/CRREL TR-05-7. Hanover, NH: US Army Engineer Research and Development Center. http://www.crrel.usace.army.mil/techpub/CRREL_Reports/reports/TR05-7.pdf.

Hewitt A. D., T. F. Jenkins, M. E. Walsh, M. R. Walsh, S. R. Bigl, and C. A. Ramsey. 2007. *Protocols for collection of surface soil samples at military training and testing ranges for the characterization of energetic munition constituents*. ERDC/CRREL TR-07-10. Hanover, NH: US Army Engineer Research and Development Center.

Hewitt, A. D., T. F. Jenkins, M. E. Walsh, S. R. Bigl, and S. Brochu. 2009. *Validation of Sampling Protocol and the Promulgation of Method Modifications for the Characterization of Energetic Residues on Military Testing and Training Ranges*. ERDC/CRREL TR-09-6. Hanover, NH: US Army Engineer Research and Development Center. http://libweb.erdc.usace.army.mil/uhtbin/cgisirsi/20110317135155/SIRSI/0/518/0/CRREL-TR-09-6.pdf.

Hewitt, A. D., T. F. Jenkins, S. R. Bigl, J. L. Clausen, H. Craig, M. E. Walsh, R. Martel, and K. Nieman. 2011. *EPA Federal Facilities Forum Issue Paper: Site Characterization for Munitions Constituents*. EPA-505-S-11-01. Washington, DC: US Environmental Protection Agency, Solid Waste and Emergency Response, Federal Facilities Forum Issue.

Idaho Geological Survey. 2011. *Geologic Mapping*. Moscow, ID: Idaho Geological Survey. http://www.idahogeology.org/Services/GeologicMapping/.

ITRC. 2003. *Characterization and Remediation of Soils at Closed Small Arms Firing Ranges*. SMART-1. Washington, DC: Interstate Technology and Regulatory Council, Incremental Sampling Methodology Team. http://www.itrcweb.org/Documents/SMART-1.pdf.

ITRC. 2012. *Technical and Regulatory Guidance: Incremental Sampling Methodology*. ISM-1. Washington, DC: Interstate Technology and Regulatory Council, Incremental Sampling Methodology Team. http://itrcweb.org/ism-1/.

Jenkins, T. F., C. L. Grant, G. S. Brar, P. G. Thorne, T. A. Ranney, and P. W. Schumacher. 1996. *Assessment of Sampling Error Associated with Collection and Analysis of Soil Samples at Explosives-Contaminated Sites*. Special Report 96-15. Hanover, NH: US Army Cold Regions Research and Engineering Laboratory.

Jenkins, T. F., M. E. Walsh, P. G. Thorne, S. Thiboutot, G. Ampleman, T. A. Ranney, and C. L. Grant. 1997a. *Assessment of Sampling Error Associated with the Collection and Analysis of Soil Samples at a Firing Range Contaminated with HMX*. Special Report 97-22. Hanover, NH: US Army Cold Regions Research and Engineering Laboratory.

Jenkins, T. F., C. L. Grant, G. S. Brar, P. G. Thorne, P. W. Schumacher, and T. A. Ranney. 1997b. Sampling Error Associated with Collection and Analysis of Soil Samples at TNT Contaminated Sites. *Field Analytical Chemistry Technology* 1:151–163.

Jenkins, T. F., M. E. Walsh, P. G. Thorne, P. H. Miyares, T. A. Ranney, C. L. Grant, and J. R. Esparza. 1998. *Site Characterization for Explosives Contamination at a Military Firing Range Impact Area*. Special Report 98-9. Hanover, NH: US Army Cold Regions Research and Engineering Laboratory.

Jenkins, T. F., C. L. Grant, M. E. Walsh, P. G. Thorne, S. Thiboutot, G. Ampleman, and T. A. Ranney. 1999. Coping with Spatial Heterogeneity Effects on Sampling and Analysis at an HMX—Contaminated Antitank Firing Range. *Field Analytical Chemistry Technology* 3:19–-28.

Jenkins, T. F., T. A. Ranney, M. E. Walsh, P. H. Miyares, A. D. Hewitt, and N. H. Collins. 2000. *Evaluating the Use of Snow-Covered Ranges to Estimate the Explosives Residues that Result from Detonation of Army Munitions*. ERDC/CRREL TR-00-15. Hanover, NH: US Army Engineer Research and Development Center.

Jenkins, T. F., J. C. Pennington, T. A. Ranney, T. E. Berry, P. H. Miyares, M. E. Walsh, A. D. Hewitt, N. M. Perron, L. V. Parker, C. A. Hayes, and E. G. Wahlgren. 2001. *Characterization of Explosives Contamination at Military Firing Range*. ERDC TR-01-5. Hanover, NH: US Army Engineer Research and Development Center.

Jenkins, T. F., T. A. Ranney, A. D. Hewitt, M. E. Walsh, and K. L. Bjella. 2004a. *Representative sampling for energetic compounds at an antitank firing range*. ERDC/CRREL TR-04-7. Hanover, NH: US Army Engineer Research and Development Center. http://www.crrel.usace.army.mil/library/technicalreports/TR04-7.pdf.

Jenkins, T. F., A. D. Hewitt, T. A. Ranney, C. A. Ramsey, D. J. Lambert, K. L. Bjella, and N. M. Perron. 2004b. *Sampling strategies near a low-order detonation and a target at an artillery impact area*. ERDC/CRREL TR-04-14. Hanover, NH: US Army Engineer Research and Development Center. http://www.crrel.usace.army.mil/library/technicalreports/TR04-14.pdf.

Jenkins, T. F., A. D. Hewitt, M. E. Walsh, T. A. Ranney, C. A. Ramsey, C. L. Grant, and K. L. Bjella. 2005a. Representative Sampling for Energetic Compounds at Military Training Ranges. *Environmental Forensics* 6:45–55.

Jenkins, T. F., A. D. Hewitt, C. L. Grant, and C. A. Ramsey. 2005b. Comment on "Data representativeness for risk assessment by Rosemary Mattuck et al., 2005." *Environmental Forensics* 6:321–322.

Jenkins, T. F., A. D. Hewitt, C. L. Grant, S. Thiboutot, G. Ampleman, M. E. Walsh, T. A. Ranney, C .A. Ramsey, A. J. Palazzo, and J. C. Pennington. 2006. Identity and distribution of residues of energetic compounds at Army live-fire training ranges. *Chemosphere* 63:1280–1290.

Johanson, J .R. 1978. Particle segregation and what to do about it. *Chemical Engineering* May:183–188.

Jorgenson, M. T., J. E. Roth, M. K. Raynolds, M. D. Smith, W. Lentz, A. L. Zusi-Cobb, and C. H. Racine. 1999. *An Ecological Land Survey for Fort Wainwright, Alaska.* Technical Report 99-09. Hanover, NH: Cold Regions Research and Engineering Laboratory.

Kimbrough, D. E., and J. R. Wakakuwa. 1989. Acid digestion for sediments, sludges, soils, and solid wastes. A proposed alternative to EPA SW 846 Method 3050. *Environmental Science and Technology* 23:898–900.

Kimbrough, D. E., and J. R. Wakakuwa. 1992. A report of the linear ranges of several acid digestion procedures. *Environmental Science and Technology* 26:173–178.

Leutwyler, K. 1993. Shaking conventional wisdom. *Scientific American* September:24.

Mann, D. H., C. L. Fastie, E. L. Rowland, and N. H. Bigelow. 1995. Spruce succession, disturbance, and geomorphology on the Tanana River floodplain, Alaska. *Ecoscience* 2:184–199.

Mason, O. K., and J. E. Beget. 1991. Late Holocene flood history of the Tanana River, Alaska, U.S.A. *Arctic and Alpine Research* 23:392–403.

Nash, M. J., J. E. Maskall, and S. J. Hill. 2000. Methodologies for determination of antimony in terrestrial environmental samples. *Journal of Environmental Monitoring* 2:97–109.

Nieman, K. C. 2007. Personal communication with Jay Clausen. Hill Air Force Base, UT: Select Engineering Services, 75 CEG/CEVC.

Page, A. L., ed. 1982. Methods of Soil Analysis, Part 2—Chemical and Microbiological Properties. 2nd ed. Madison, WI: American Society of Agronomy.

Pennington, J. C., et al. 2004. *Distribution and fate of energetics on DoD test and training ranges: Interim Report 4.* ERDC TR-04-4. Vicksburg, MS: US Army Engineer Research and Development Center. http://el.erdc.usace.army.mil/elpubs/pdf/tr04-4.pdf.

Péwé, T. L. 1975. *Quaternary geology of Alaska*. Geological Survey Professional Paper 835. Washington, DC: US Geological Survey.

Péwé, T. L., C. Wahrhaftig, and F. Weber. 1966. *Geologic map of the Fairbanks Quadrangle, Alaska*. Map I-455. Washington, DC: US Geological Survey.

Péwé, T. L, J. W. Bell, R. B. Forbes, and F. R. Weber. 1976. *Geologic map of the Fairbanks D-2 SE Quadrangle, Alaska*. Miscellaneous Investigations Series Map I-942. Washington, DC: US Geological Survey.

Pitard, F. F. 1993. *Pierre Gy's Sampling Theroy and Sampling Practice: Heterogeneity, Sampling Correctness, and Statistical Process Control*. Boca Raton, FL: CRC Press.

Racine, C. H., M. E. Walsh, C. M. Collins, D. J. Calkins, B. D. Roebuck, and L. Reitsma. 1992. *Waterfowl Mortality in Eagle River Flats, Alaska: The Role of Munition Residues*. CRREL Report 92-5. Hanover, NH: Cold Regions Research and Engineering Laboratory.

Rieger, S., J. A. Dement, and D. Sanders. 1963. *Soil Survey of Fairbanks Area, Alaska*. Washington, DC: US Government Printing Office.

Rieger, S., D. B. Schoephorster, and C. E. Furbush. 1979. *Exploratory soil survey of Alaska*. Washington, DC: Soil Conservation Service, US Department of Agriculture.

StatSoft, Inc. 2012. *Statistica Help*. Tulsa, OK: StatSoft, Inc. http://documentation.statsoft.com/STATISTICAHelp.aspx?path=glossary/GlossaryTwo/L/LeveneandBrownForsythetestsforhomogeneityofvariancesHOV.

Studt, T. 1995. For material researchers, It's back to the sandbox. *R&D Magazine* July:41–42.

Swanson, D. K., and M. Mungoven. 1998. *Soil survey of Eielson Air Force Base, Alaska (an Interim Report)*. Fairbanks, AK: Natural Resource Conservation Service.

Taylor S., A. Hewitt, J. Lever, C. Hayes, L. Perovich, P. Thorne, and P. Daghalin. 2004. TNT particle size distribution for detonated 155-mm howitzer rounds. *Chemosphere* 55:357–367.

Thiboutot, S., G. Ampleman, A. Gagnon, A. Marois, T. F. Jenkins, M. E. Walsh, P. G. Thorne, and T.A. Ranney. 1998. *Characterization of Antitank Firing Ranges at CDB Valcartier, WATC Wainwright and CFAD Dundurn*. Quebec, Canada: Defence Research Establishment—Valcartier.

Thiboutot, S., G. Ampleman, A. Gagnon, and A. Marois. 2000a. *Characterization of an Unexploded Ordinance Contaminated Range (Tracadie Range) for Potential Contamination by Energetic Materials*. DREV-TR-2000-102. Quebec, Canada: Defence Research Establishment—Valcartier.

Thiboutot, S., G. Ampleman, P. Dube, C. Dubois, R. Martel, R. Lefebvre, M. Mailloux, G. Sunahara, P. Y. Roubidoux, and J. Hawari. 2000b. *Characterization of DND Training Ranges Including Anti-Tank Firing Ranges and Ecotoxicological Assessment.* Quebec, Canada: Defence Research Establishment—Valcartier.

Thiboutot, S., G. Ampleman, and A.D. Hewitt. 2002. *Guide for Characterization of Sites Contaminated with Energetic Materials.* ERDC/CRREL TR-02-1. Hanover, NH: US Army Engineer Research and Development Center.

Thiboutot, S., G. Ampleman, J. Lewis, D. Faucher, A. Marois, R. Martel, J. M. Ballard, S. Downe, T. F. Jenkins, A. Hewitt. 2003. *Environmental Conditions of Surface Soils and Biomass Prevailing in the Training Area at CFB Gagetown, New Brunswick*. DRDC-TR-2003-152, Quebec, Canada: Defence Research Development Canada—Valcartier.

URS. 2007. *Final Site Inspection Report, Fort Eustis Fort Eustis, Virginia, Military Munitions Response Program*. Gaithersburg, MD: URS Group Inc.,

URS. 2010. *Remedial Investigation/Feasibility Study 1000" Rifle Range Fort Eustis, Virginia Military Munitions Response Program, Volume 1: Remedial Investigation*. Gaithersburg, MD: URS Group Inc.

USACE. 1972. *Environmental Analysis Record: Amended Special Land-use Permit Application, I-2407*. Seattle, WA: US Corps of Engineers, Seattle District.

USACE. 2009. *Implementation of Incremental Sampling (IS) of Soil for the Military Munitions Response Program, Environmental and Munitions Center of Expertise Interim Guidance Document (IGD) 09-02*. Huntsville, AL: Department of the Army, Huntsville Center, Corps of Engineers.

USEPA. 1996a. Method 3050B: Acid Digestion of Sediments, Sludges, and Soils. In *Test Methods for Evaluating Solid Waste, Physical/Chemical Methods*. SW-846. Washington, DC: US Environmental Protection Agency, Office of Solid Waste and Emergency Response.

USEPA. 1996b. Method 3051A: Microwave Assisted Acid Digestion of Sediments, Sludges, Soils, and Oils. In *Test Methods for Evaluating Solid Waste, Physical/Chemical Methods*. SW-846. Washington, DC: US Environmental Protection Agency, Office of Solid Waste and Emergency Response.

USEPA. 2000. *Administrative Order for Massachusetts Military Reservation Training and Impact Area Response Actions.* EPA Docket No. SDWA-1-2000-0014. Boston, Massachusetts: US Environmental Protection Agency Region 1.

USEPA. 2006. Method 8330B: Nitroaromatics, nitramines, nitrate esters by high performance liquid chromatography (HPLC). In *Test Methods for Evaluating Solid Waste, Physical/Chemical Methods.* SW-846. Washington, DC: US Environmental Protection Agency, Office of Solid Waste and Emergency Response. http://www.epa.gov/epaoswer/hazwaste/test/pdfs/8330b.pdf.

Viereck, L. A., and K. Van Cleve. 1984. Some aspects of vegetation and temperature relationships in the Alaska taiga. In *The Potential Effects of Carbon-Dioxide-Induced Climate Changes in Alaska: The Proceedings of a Conference*, ed. J. H. McBeath, 129–142. Fairbanks, AK:University of Alaska.

Wallace, D. and B. Kratochvil. 1985. Use of a mill and spinning riffle for subsampling laboratory samples of oil sand. *Austria Journal of Research* 2: 233–239.

Walsh, M. E., and C. M. Collins. 1993. *Distribution of White Phosphorus in Residues from the Detonation of 81 mm Mortar WP Smoke Rounds*. Special Report 93-18. Hanover, NH: US Army Cold Regions Research and Engineering Laboratory.

Walsh, M. E., and D. J. Lambert. 2006. *Extraction Kinetics of Energetic Compounds from Training Range and Army Ammunition Plant Soils: Platform Shaker versus Sonic Bath Methods*. ERDC/CRREL TR-06-6. Hanover, NH: US Army Engineer Research and Development Center.

Walsh, M. E., T. F. Jenkins, P. H. Miyares, P. S. Schnitker, J. W. Elwell, and M. H. Stutz. 1993. *Evaluation of SW846 Method 8330 for Characterization of Sites Contaminated with Residues of High Explosives*. CRREL Report 93-5. Hanover, NH: US Army Cold Regions Research and Engineering Laboratory.

Walsh, M. E., C. M. Collins, R. N. Bailey, and C. L. Grant. 1997. *Composite Sampling of Sediments Contaminated with White Phosphorus*. Special Report 97-30. Hanover, NH: US Army Cold Regions Research and Engineering Laboratory.

Walsh, M. E., C. A. Ramsey, and T. F. Jenkins. 2002. The Effect of Particle Size Reduction on Sub sampling Variance for Explosives Residues in Soil. *Chemosphere* 49:1265–1271.

Walsh, M. E., C. M. Collins, T. F. Jenkins, A. D. Hewitt, J. Stark, and K. Myers. 2003. Sampling for Explosives-Residues at Ft. Greely. *Soil and Sediment Contamination* 12:631–645.

Walsh, M. E., C. M. Collins, A. D. Hewitt, M. R. Walsh, T. F. Jenkins, J. Stark, A. Gelvin, T. S. Douglas, N. Perron, D. Lambert, R. Bailey and K. Meyers. 2004. *Range characterization studies at Donnelly Training Area, Alaska: 2001 and 2003*. ERDC/CRREL TR-04-3. Hanover, NH: US Army Engineer Research and Development Center. http://www.crrel.usace.army.mil/library/technicalreports/TR04-3.pdf.

Walsh, M. E., C. A. Ramsey, C. M. Collins, A. D. Hewitt, M. R. Walsh, K. Bjella, D. Lambert, and N. Perron. 2005. Collection methods and laboratory processing of samples from Donnelly Training Area Firing Points Alaska 2003. ERDC/CRREL TR-05-6. Hanover, NH: US Army Engineer Research and Development Center. http://www.crrel.usace.army.mil/library/technicalreports/TR05-6.pdf.

Walsh, M. E., C. A. Ramsey, S. Taylor, A. D. Hewitt, K. Bjella, C. M. Collins. 2006. Sub sampling Variance for 2,4-DNT in Firing Point Soils. *Soil and Sediment Contamination: an International Journal* 16(5):459–472.

Walsh, M. R. 2007. *Explosives Residues Resulting from the Detonation of Common Military Munitions: 2002–2006*. ERDC/CRREL TR-07-2. Hanover, NH: US Army Engineer Research and Development Center.

Walsh, M. R. 2009. *User's Manual for the CRREL Multi-Increment Sampling Tool.* ERDC/CRREL SR-09-1. Hanover, NH: US Army Engineer Research and Development Center. http://acwc.sdp.sirsi.net/client/default.

Williams, J. R. 1970. *Ground Water in the Permafrost Regions of Alaska.* Washington, DC: US Government Printing Office.

Appendix A: Points of Contact

POINT OF CONTACT Name	ORGANIZATION Name Address	Phone Fax E-mail	Role in Project
Jay Clausen	ERDC/CRREL 72 Lyme Road Hanover, NH 03755	603-646-4597 603-646-4785 jay.l.clausen@us.army.mil	PI
Anthony Bednar	ERDC/EL 3909 Halls Ferry Road EP-C Building 3299 RM 106 Vicksburg, MS 39180-6199	601-634-3652 601-634-2742 anthony.j.bednar.usa.army.mil	Co-PI
Thomas Georgian	USACE EM CX 1616 Capitol Ave Omaha, NE 68102	402-697-2567 thomas.georgian@us.army.mil	Co-PI
Larry Penfold	Test America 4955 Yarrow St Arvada, CO 80002	303-736-0119 303-502-6559 larry.Penfold@testamericainc.com	Industry Partner
Diane Anderson	APPL, Inc. 908 N. Temperance Ave. Clovis, CA 93611	559-275-2175 559-275-4422 danderson@applinc.com	Industry Partner
Amber Michel	AGEISS, Inc. 733d MSG/CED/AMF/EE 1407 Washington Blvd. JBLE (Fort Eustis), Virginia 23604-5306	757-878-4123 ext 296 757-878-4589 Amber.Michel@us.army.mil	Fort Eustis Site Access

Appendix B: Quality Assurance/Quality Control (QA/QC) Results

SAMPID	TYPE	MATRIX	PREPDATE	ANADATE	BATCH	ANALYTE	RESULT	DL	RL	UNITS	DIL	SORC ID	SORC RES	SPIKE LVL	REC	RPD	U CL	L CL	RPDCL
B205009-BLK1	Blank	Soil/Sed	06/16/2012 12:23:00	06/16/2012 12:25:06	B205009	CEC	0.00848			meq/g	1	NA	NA	NA	NA	NA	NA	NA	NA
B205009-DUP1	Dup	Soil/Sed	06/16/2012 12:23:00	06/16/2012 12:25:06	B205009	CEC	0.801			meq/g	1	20430 03-01	0.769	NA	NA	4.10	NA	NA	20
B205038-BLK1	Blank	Soil/Sed	05/11/2012 09:23:00	05/14/2012 14:37:00	B205038	Aluminum	ND	2.00	4.00	mg/kg	2	NA	NA	NA	NA	NA	NA	NA	NA
B205038-BLK1	Blank	Soil/Sed	05/11/2012 09:23:00	05/14/2012 14:37:00	B205038	Copper	ND	2.00	4.00	mg/kg	2	NA	NA	NA	NA	NA	NA	NA	NA
B205038-BLK1	Blank	Soil/Sed	05/11/2012 09:23:00	05/14/2012 14:37:00	B205038	Iron	ND	2.00	4.00	mg/kg	2	NA	NA	NA	NA	NA	NA	NA	NA
B205038-BLK1	Blank	Soil/Sed	05/11/2012 09:23:00	05/14/2012 14:37:00	B205038	Lead	ND	2.00	4.00	mg/kg	2	NA	NA	NA	NA	NA	NA	NA	NA
B205038-BLK1	Blank	Soil/Sed	05/11/2012 09:23:00	05/14/2012 14:37:00	B205038	Magnesium	ND	2.00	4.00	mg/kg	2	NA	NA	NA	NA	NA	NA	NA	NA
B205038-BLK1	Blank	Soil/Sed	05/11/2012 09:23:00	05/14/2012 14:37:00	B205038	Manganese	ND	2.00	4.00	mg/kg	2	NA	NA	NA	NA	NA	NA	NA	NA
B205038-BLK1	Blank	Soil/Sed	05/11/2012 09:23:00	05/14/2012 14:37:00	B205038	Nickel	ND	2.00	4.00	mg/kg	2	NA	NA	NA	NA	NA	NA	NA	NA
B205038-BLK1	Blank	Soil/Sed	05/11/2012 09:23:00	05/14/2012 14:37:00	B205038	Phosphorus	ND	2.00	4.00	mg/kg	2	NA	NA	NA	NA	NA	NA	NA	NA
B205038-BLK1	Blank	Soil/Sed	05/11/2012 09:23:00	05/14/2012 14:37:00	B205038	Potassium	ND	2.00	4.00	mg/kg	2	NA	NA	NA	NA	NA	NA	NA	NA
B205038-BLK1	Blank	Soil/Sed	05/11/2012 09:23:00	05/14/2012 14:37:00	B205038	Selenium	ND	2.00	4.00	mg/kg	2	NA	NA	NA	NA	NA	NA	NA	NA
B205038-BLK1	Blank	Soil/Sed	05/11/2012 09:23:00	05/14/2012 14:37:00	B205038	Antimony	ND	2.00	4.00	mg/kg	2	NA	NA	NA	NA	NA	NA	NA	NA
B205038-BLK1	Blank	Soil/Sed	05/11/2012 09:23:00	05/14/2012 14:37:00	B205038	Silver	ND	2.00	4.00	mg/kg	2	NA	NA	NA	NA	NA	NA	NA	NA
B205038-BLK1	Blank	Soil/Sed	05/11/2012 09:23:00	05/14/2012 14:37:00	B205038	Sodium	ND	2.00	4.00	mg/kg	2	NA	NA	NA	NA	NA	NA	NA	NA
B205038-BLK1	Blank	Soil/Sed	05/11/2012 09:23:00	05/14/2012 14:37:00	B205038	Thallium	ND	2.00	4.00	mg/kg	2	NA	NA	NA	NA	NA	NA	NA	NA
B205038-BLK1	Blank	Soil/Sed	05/11/2012 09:23:00	05/14/2012 14:37:00	B205038	Vanadium	ND	2.00	4.00	mg/kg	2	NA	NA	NA	NA	NA	NA	NA	NA
B205038-BLK1	Blank	Soil/Sed	05/11/2012 09:23:00	05/14/2012 14:37:00	B205038	Zinc	ND	2.00	4.00	mg/kg	2	NA	NA	NA	NA	NA	NA	NA	NA

SAMPID	TYPE	MATRIX	PREPDATE	ANADATE	BATCH	ANALYTE	RESULT	DL	RL	UNITS	DIL	SORC ID	SORC RES	SPIKE LVL	REC	RPD	U CL	L CL	RPDCL
B205038-BLK1	Blank	Soil/Sed	05/11/2012 09:23:00	05/14/2012 14:37:00	B205038	Arsenic	ND	2.00	4.00	mg/kg	2	NA	NA	NA	NA	NA	NA	NA	NA
B205038-BLK1	Blank	Soil/Sed	05/11/2012 09:23:00	05/14/2012 14:37:00	B205038	Barium	ND	2.00	4.00	mg/kg	2	NA	NA	NA	NA	NA	NA	NA	NA
B205038-BLK1	Blank	Soil/Sed	05/11/2012 09:23:00	05/14/2012 14:37:00	B205038	Beryllium	ND	2.00	4.00	mg/kg	2	NA	NA	NA	NA	NA	NA	NA	NA
B205038-BLK1	Blank	Soil/Sed	05/11/2012 09:23:00	05/14/2012 14:37:00	B205038	Cadmium	ND	2.00	4.00	mg/kg	2	NA	NA	NA	NA	NA	NA	NA	NA
B205038-BLK1	Blank	Soil/Sed	05/11/2012 09:23:00	05/14/2012 14:37:00	B205038	Calcium	ND	2.00	4.00	mg/kg	2	NA	NA	NA	NA	NA	NA	NA	NA
B205038-BLK1	Blank	Soil/Sed	05/11/2012 09:23:00	05/14/2012 14:37:00	B205038	Chromium	ND	2.00	4.00	mg/kg	2	NA	NA	NA	NA	NA	NA	NA	NA
B205038-BLK1	Blank	Soil/Sed	05/11/2012 09:23:00	05/14/2012 14:37:00	B205038	Cobalt	ND	2.00	4.00	mg/kg	2	NA	NA	NA	NA	NA	NA	NA	NA
B205038-BS1	LCS	Soil/Sed	05/11/2012 09:23:00	05/14/2012 14:37:00	B205038	Aluminum	245	2.00	4.00	mg/kg	2	NA	NA	250.0	98.1	NA	120	80	NA
B205038-BS1	LCS	Soil/Sed	05/11/2012 09:23:00	05/14/2012 14:37:00	B205038	Copper	252	2.00	4.00	mg/kg	2	NA	NA	250.0	101	NA	120	80	NA
B205038-BS1	LCS	Soil/Sed	05/11/2012 09:23:00	05/14/2012 14:37:00	B205038	Iron	258	2.00	4.00	mg/kg	2	NA	NA	250.0	103	NA	120	80	NA
B205038-BS1	LCS	Soil/Sed	05/11/2012 09:23:00	05/14/2012 14:37:00	B205038	Lead	252	2.00	4.00	mg/kg	2	NA	NA	250.0	101	NA	120	80	NA
B205038-BS1	LCS	Soil/Sed	05/11/2012 09:23:00	05/14/2012 14:37:00	B205038	Magnesium	251	2.00	4.00	mg/kg	2	NA	NA	250.0	101	NA	120	80	NA
B205038-BS1	LCS	Soil/Sed	05/11/2012 09:23:00	05/14/2012 14:37:00	B205038	Manganese	249	2.00	4.00	mg/kg	2	NA	NA	250.0	99.6	NA	120	80	NA
B205038-BS1	LCS	Soil/Sed	05/11/2012 09:23:00	05/14/2012 14:37:00	B205038	Nickel	255	2.00	4.00	mg/kg	2	NA	NA	250.0	102	NA	120	80	NA
B205038-BS1	LCS	Soil/Sed	05/11/2012 09:23:00	05/14/2012 14:37:00	B205038	Phosphorus	241	2.00	4.00	mg/kg	2	NA	NA	250.0	96.6	NA	120	80	NA
B205038-BS1	LCS	Soil/Sed	05/11/2012 09:23:00	05/14/2012 14:37:00	B205038	Potassium	237	2.00	4.00	mg/kg	2	NA	NA	250.0	94.7	NA	120	80	NA
B205038-BS1	LCS	Soil/Sed	05/11/2012 09:23:00	05/14/2012 14:37:00	B205038	Selenium	243	2.00	4.00	mg/kg	2	NA	NA	250.0	97.4	NA	120	80	NA
B205038-BS1	LCS	Soil/Sed	05/11/2012 09:23:00	05/14/2012 14:37:00	B205038	Antimony	243	2.00	4.00	mg/kg	2	NA	NA	250.0	97.1	NA	120	80	NA

SAMPID	TYPE	MATRIX	PREPDATE	ANADATE	BATCH	ANALYTE	RESULT	DL	RL	UNITS	DIL	SORC ID	SORC RES	SPIKE LVL	REC	RPD	U CL	L CL	RPDCL
B205038-BS1	LCS	Soil/Sed	05/11/2012 09:23:00	05/14/2012 14:37:00	B205038	Silver	244	2.00	4.00	mg/kg	2	NA	NA	250.0	97.8	NA	120	80	NA
B205038-BS1	LCS	Soil/Sed	05/11/2012 09:23:00	05/14/2012 14:37:00	B205038	Sodium	245	2.00	4.00	mg/kg	2	NA	NA	250.0	97.8	NA	120	80	NA
B205038-BS1	LCS	Soil/Sed	05/11/2012 09:23:00	05/14/2012 14:37:00	B205038	Thallium	253	2.00	4.00	mg/kg	2	NA	NA	250.0	101	NA	120	80	NA
B205038-BS1	LCS	Soil/Sed	05/11/2012 09:23:00	05/14/2012 14:37:00	B205038	Vanadium	243	2.00	4.00	mg/kg	2	NA	NA	250.0	97.2	NA	120	80	NA
B205038-BS1	LCS	Soil/Sed	05/11/2012 09:23:00	05/14/2012 14:37:00	B205038	Zinc	258	2.00	4.00	mg/kg	2	NA	NA	250.0	103	NA	120	80	NA
B205038-BS1	LCS	Soil/Sed	05/11/2012 09:23:00	05/14/2012 14:37:00	B205038	Arsenic	243	2.00	4.00	mg/kg	2	NA	NA	250.0	97.0	NA	120	80	NA
B205038-BS1	LCS	Soil/Sed	05/11/2012 09:23:00	05/14/2012 14:37:00	B205038	Barium	245	2.00	4.00	mg/kg	2	NA	NA	250.0	97.9	NA	120	80	NA
B205038-BS1	LCS	Soil/Sed	05/11/2012 09:23:00	05/14/2012 14:37:00	B205038	Beryllium	246	2.00	4.00	mg/kg	2	NA	NA	250.0	98.3	NA	120	80	NA
B205038-BS1	LCS	Soil/Sed	05/11/2012 09:23:00	05/14/2012 14:37:00	B205038	Cadmium	195	2.00	4.00	mg/kg	2	NA	NA	250.0	77.8	NA	120	80	NA
B205038-BS1	LCS	Soil/Sed	05/11/2012 09:23:00	05/14/2012 14:37:00	B205038	Calcium	252	2.00	4.00	mg/kg	2	NA	NA	250.0	101	NA	120	80	NA
B205038-BS1	LCS	Soil/Sed	05/11/2012 09:23:00	05/14/2012 14:37:00	B205038	Chromium	253	2.00	4.00	mg/kg	2	NA	NA	250.0	101	NA	120	80	NA
B205038-BS1	LCS	Soil/Sed	05/11/2012 09:23:00	05/14/2012 14:37:00	B205038	Cobalt	250	2.00	4.00	mg/kg	2	NA	NA	250.0	100	NA	120	80	NA
B207045-BLK1	Blank	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Aluminum	ND	0.0200	0.0400	mg/L	2	NA	NA	NA	NA	NA	NA	NA	NA
B207045-BLK1	Blank	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Cobalt	ND	0.0200	0.0400	mg/L	2	NA	NA	NA	NA	NA	NA	NA	NA
B207045-BLK1	Blank	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Copper	ND	0.0200	0.0400	mg/L	2	NA	NA	NA	NA	NA	NA	NA	NA
B207045-BLK1	Blank	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Iron	ND	0.0200	0.0400	mg/L	2	NA	NA	NA	NA	NA	NA	NA	NA
B207045-BLK1	Blank	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Lead	ND	0.0200	0.0400	mg/L	2	NA	NA	NA	NA	NA	NA	NA	NA
B207045-BLK1	Blank	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Magnesium	ND	0.0200	0.0400	mg/L	2	NA	NA	NA	NA	NA	NA	NA	NA

SAMPID	TYPE	MATRIX	PREPDATE	ANADATE	BATCH	ANALYTE	RESULT	DL	RL	UNITS	DIL	SORC ID	SORC RES	SPIKE LVL	REC	RPD	U CL	L CL	RPDCL
B207045-BLK1	Blank	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Manganese	ND	0.0200	0.0400	mg/L	2	NA	NA	NA	NA	NA	NA	NA	NA
B207045-BLK1	Blank	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Nickel	ND	0.0200	0.0400	mg/L	2	NA	NA	NA	NA	NA	NA	NA	NA
B207045-BLK1	Blank	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Phosphorus	ND	0.0200	0.0400	mg/L	2	NA	NA	NA	NA	NA	NA	NA	NA
B207045-BLK1	Blank	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Potassium	ND	0.0200	0.0400	mg/L	2	NA	NA	NA	NA	NA	NA	NA	NA
B207045-BLK1	Blank	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Antimony	ND	0.0200	0.0400	mg/L	2	NA	NA	NA	NA	NA	NA	NA	NA
B207045-BLK1	Blank	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Selenium	ND	0.0200	0.0400	mg/L	2	NA	NA	NA	NA	NA	NA	NA	NA
B207045-BLK1	Blank	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Silver	ND	0.0200	0.0400	mg/L	2	NA	NA	NA	NA	NA	NA	NA	NA
B207045-BLK1	Blank	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Sodium	ND	0.0200	0.0400	mg/L	2	NA	NA	NA	NA	NA	NA	NA	NA
B207045-BLK1	Blank	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Thallium	ND	0.0200	0.0400	mg/L	2	NA	NA	NA	NA	NA	NA	NA	NA
B207045-BLK1	Blank	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Arsenic	ND	0.0200	0.0400	mg/L	2	NA	NA	NA	NA	NA	NA	NA	NA
B207045-BLK1	Blank	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Vanadium	ND	0.0200	0.0400	mg/L	2	NA	NA	NA	NA	NA	NA	NA	NA
B207045-BLK1	Blank	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Zinc	ND	0.0200	0.0400	mg/L	2	NA	NA	NA	NA	NA	NA	NA	NA
B207045-BLK1	Blank	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Barium	ND	0.0200	0.0400	mg/L	2	NA	NA	NA	NA	NA	NA	NA	NA
B207045-BLK1	Blank	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Beryllium	ND	0.0200	0.0400	mg/L	2	NA	NA	NA	NA	NA	NA	NA	NA
B207045-BLK1	Blank	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Cadmium	ND	0.0200	0.0400	mg/L	2	NA	NA	NA	NA	NA	NA	NA	NA
B207045-BLK1	Blank	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Calcium	ND	0.0200	0.0400	mg/L	2	NA	NA	NA	NA	NA	NA	NA	NA
B207045-BLK1	Blank	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Chromium	ND	0.0200	0.0400	mg/L	2	NA	NA	NA	NA	NA	NA	NA	NA
B207045-BS1	LCS	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Aluminum	2.45	0.0200	0.0400	mg/L	2	NA	NA	2.500	98.1	NA	120	80	NA

SAMPID	TYPE	MATRIX	PREPDATE	ANADATE	BATCH	ANALYTE	RESULT	DL	RL	UNITS	DIL	SORC ID	SORC RES	SPIKE LVL	REC	RPD	U CL	L CL	RPDCL
B207045-BS1	LCS	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Cobalt	2.50	0.0200	0.0400	mg/L	2	NA	NA	2.500	100	NA	120	80	NA
B207045-BS1	LCS	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Copper	2.52	0.0200	0.0400	mg/L	2	NA	NA	2.500	101	NA	120	80	NA
B207045-BS1	LCS	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Iron	2.58	0.0200	0.0400	mg/L	2	NA	NA	2.500	103	NA	120	80	NA
B207045-BS1	LCS	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Lead	2.52	0.0200	0.0400	mg/L	2	NA	NA	2.500	101	NA	120	80	NA
B207045-BS1	LCS	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Magnesium	2.51	0.0200	0.0400	mg/L	2	NA	NA	2.500	101	NA	120	80	NA
B207045-BS1	LCS	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Manganese	2.49	0.0200	0.0400	mg/L	2	NA	NA	2.500	99.6	NA	120	80	NA
B207045-BS1	LCS	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Nickel	2.55	0.0200	0.0400	mg/L	2	NA	NA	2.500	102	NA	120	80	NA
B207045-BS1	LCS	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Phosphorus	2.41	0.0200	0.0400	mg/L	2	NA	NA	2.500	96.6	NA	120	80	NA
B207045-BS1	LCS	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Potassium	2.37	0.0200	0.0400	mg/L	2	NA	NA	2.500	94.7	NA	120	80	NA
B207045-BS1	LCS	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Antimony	2.43	0.0200	0.0400	mg/L	2	NA	NA	2.500	97.1	NA	120	80	NA
B207045-BS1	LCS	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Selenium	2.43	0.0200	0.0400	mg/L	2	NA	NA	2.500	97.4	NA	120	80	NA
B207045-BS1	LCS	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Silver	2.44	0.0200	0.0400	mg/L	2	NA	NA	2.500	97.8	NA	120	80	NA
B207045-BS1	LCS	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Sodium	2.45	0.0200	0.0400	mg/L	2	NA	NA	2.500	97.8	NA	120	80	NA
B207045-BS1	LCS	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Thallium	2.53	0.0200	0.0400	mg/L	2	NA	NA	2.500	101	NA	120	80	NA
B207045-BS1	LCS	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Arsenic	2.43	0.0200	0.0400	mg/L	2	NA	NA	2.500	97.0	NA	120	80	NA
B207045-BS1	LCS	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Vanadium	2.43	0.0200	0.0400	mg/L	2	NA	NA	2.500	97.2	NA	120	80	NA
B207045-BS1	LCS	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Zinc	2.58	0.0200	0.0400	mg/L	2	NA	NA	2.500	103	NA	120	80	NA
B207045-BS1	LCS	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Barium	2.45	0.0200	0.0400	mg/L	2	NA	NA	2.500	97.9	NA	120	80	NA

SAMPID	TYPE	MATRIX	PREPDATE	ANADATE	BATCH	ANALYTE	RESULT	DL	RL	UNITS	DIL	SORC ID	SORC RES	SPIKE LVL	REC	RPD	U CL	L CL	RPDCL
B207045-BS1	LCS	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Beryllium	2.46	0.0200	0.0400	mg/L	2	NA	NA	2.500	98.3	NA	120	80	NA
B207045-BS1	LCS	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Cadmium	1.95	0.0200	0.0400	mg/L	2	NA	NA	2.500	77.8	NA	120	80	NA
B207045-BS1	LCS	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Calcium	2.52	0.0200	0.0400	mg/L	2	NA	NA	2.500	101	NA	120	80	NA
B207045-BS1	LCS	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Chromium	2.53	0.0200	0.0400	mg/L	2	NA	NA	2.500	101	NA	120	80	NA
B207045-DUP1	Dup	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Aluminum	0.0562	0.0200	0.0400	mg/L	2	20510 01-01	0.0552	NA	NA	1.79	NA	NA	20
B207045-DUP1	Dup	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Cobalt	ND	0.0200	0.0400	mg/L	2	20510 01-01	ND	NA	NA		NA	NA	20
B207045-DUP1	Dup	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Copper	0.0401	0.0200	0.0400	mg/L	2	20510 01-01	0.0488	NA	NA	19.8	NA	NA	20
B207045-DUP1	Dup	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Iron	0.333	0.0200	0.0400	mg/L	2	20510 01-01	0.333	NA	NA	0.0736	NA	NA	20
B207045-DUP1	Dup	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Lead	ND	0.0200	0.0400	mg/L	2	20510 01-01	0.0240	NA	NA		NA	NA	20
B207045-DUP1	Dup	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Magnesium	0.163	0.0200	0.0400	mg/L	2	20510 01-01	0.147	NA	NA	10.1	NA	NA	20
B207045-DUP1	Dup	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Manganese	0.0238	0.0200	0.0400	mg/L	2	20510 01-01	0.0241	NA	NA	1.31	NA	NA	20
B207045-DUP1	Dup	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Nickel	0.106	0.0200	0.0400	mg/L	2	20510 01-01	0.109	NA	NA	2.85	NA	NA	20
B207045-DUP1	Dup	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Phosphorus	ND	0.0200	0.0400	mg/L	2	20510 01-01	ND	NA	NA		NA	NA	20
B207045-DUP1	Dup	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Potassium	0.289	0.0200	0.0400	mg/L	2	20510 01-01	0.390	NA	NA	29.7	NA	NA	20
B207045-DUP1	Dup	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Antimony	ND	0.0200	0.0400	mg/L	2	20510 01-01	0.0285	NA	NA		NA	NA	20
B207045-DUP1	Dup	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Selenium	ND	0.0200	0.0400	mg/L	2	20510 01-01	ND	NA	NA		NA	NA	20
B207045-DUP1	Dup	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Silver	ND	0.0200	0.0400	mg/L	2	20510 01-01	0.0220	NA	NA		NA	NA	20
B207045-DUP1	Dup	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Sodium	0.141	0.0200	0.0400	mg/L	2	20510 01-01	0.177	NA	NA	22.5	NA	NA	20

SAMPID	TYPE	MATRIX	PREPDATE	ANADATE	BATCH	ANALYTE	RESULT	DL	RL	UNITS	DIL	SORC ID	SORC RES	SPIKE LVL	REC	RPD	U CL	L CL	RPDCL
B207045-DUP1	Dup	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Thallium	ND	0.0200	0.0400	mg/L	2	2051001-01	ND	NA	NA		NA	NA	20
B207045-DUP1	Dup	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Arsenic	ND	0.0200	0.0400	mg/L	2	2051001-01	ND	NA	NA		NA	NA	20
B207045-DUP1	Dup	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Vanadium	ND	0.0200	0.0400	mg/L	2	2051001-01	ND	NA	NA		NA	NA	20
B207045-DUP1	Dup	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Zinc	0.0442	0.0200	0.0400	mg/L	2	2051001-01	0.0757	NA	NA	52.5	NA	NA	20
B207045-DUP1	Dup	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Barium	ND	0.0200	0.0400	mg/L	2	2051001-01	ND	NA	NA		NA	NA	20
B207045-DUP1	Dup	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Beryllium	ND	0.0200	0.0400	mg/L	2	2051001-01	ND	NA	NA		NA	NA	20
B207045-DUP1	Dup	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Cadmium	ND	0.0200	0.0400	mg/L	2	2051001-01	0.0315	NA	NA		NA	NA	20
B207045-DUP1	Dup	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Calcium	0.265	0.0200	0.0400	mg/L	2	2051001-01	0.278	NA	NA	4.78	NA	NA	20
B207045-DUP1	Dup	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Chromium	0.0896	0.0200	0.0400	mg/L	2	2051001-01	0.0927	NA	NA	3.49	NA	NA	20
B207045-DUP2	Dup	Water	05/22/2012 00:00:00	05/25/2012 16:10:00	B207045	Aluminum	0.0535	0.0200	0.0400	mg/L	2	2052501-01	0.0354	NA	NA	40.7	NA	NA	20
B207045-DUP2	Dup	Water	05/22/2012 00:00:00	05/25/2012 16:10:00	B207045	Cobalt	ND	0.0200	0.0400	mg/L	2	2052501-01	ND	NA	NA		NA	NA	20
B207045-DUP2	Dup	Water	05/22/2012 00:00:00	05/25/2012 16:10:00	B207045	Copper	0.0451	0.0200	0.0400	mg/L	2	2052501-01	0.0653	NA	NA	36.7	NA	NA	20
B207045-DUP2	Dup	Water	05/22/2012 00:00:00	05/25/2012 16:10:00	B207045	Iron	0.0995	0.0200	0.0400	mg/L	2	2052501-01	0.0801	NA	NA	21.6	NA	NA	20
B207045-DUP2	Dup	Water	05/22/2012 00:00:00	05/25/2012 16:10:00	B207045	Lead	0.0710	0.0200	0.0400	mg/L	2	2052501-01	0.196	NA	NA	93.8	NA	NA	20
B207045-DUP2	Dup	Water	05/22/2012 00:00:00	05/25/2012 16:10:00	B207045	Magnesium	0.192	0.0200	0.0400	mg/L	2	2052501-01	0.135	NA	NA	34.6	NA	NA	20
B207045-DUP2	Dup	Water	05/22/2012 00:00:00	05/25/2012 16:10:00	B207045	Manganese	ND	0.0200	0.0400	mg/L	2	2052501-01	ND	NA	NA		NA	NA	20
B207045-DUP2	Dup	Water	05/22/2012 00:00:00	05/25/2012 16:10:00	B207045	Nickel	ND	0.0200	0.0400	mg/L	2	2052501-01	ND	NA	NA		NA	NA	20
B207045-DUP2	Dup	Water	05/22/2012 00:00:00	05/25/2012 16:10:00	B207045	Phosphorus	0.0495	0.0200	0.0400	mg/L	2	2052501-01	0.0708	NA	NA	35.5	NA	NA	20

SAMPID	TYPE	MATRIX	PREPDATE	ANADATE	BATCH	ANALYTE	RESULT	DL	RL	UNITS	DIL	SORC ID	SORC RES	SPIKE LVL	REC	RPD	U CL	L CL	RPDCL
B207045-DUP2	Dup	Water	05/22/2012 00:00:00	05/25/2012 16:10:00	B207045	Potassium	0.516	0.0200	0.0400	mg/L	2	2052501-01	0.488	NA	NA	5.57	NA	NA	20
B207045-DUP2	Dup	Water	05/22/2012 00:00:00	05/25/2012 16:10:00	B207045	Antimony	0.0687	0.0200	0.0400	mg/L	2	2052501-01	0.152	NA	NA	75.5	NA	NA	20
B207045-DUP2	Dup	Water	05/22/2012 00:00:00	05/25/2012 16:10:00	B207045	Selenium	ND	0.0200	0.0400	mg/L	2	2052501-01	ND	NA	NA		NA	NA	20
B207045-DUP2	Dup	Water	05/22/2012 00:00:00	05/25/2012 16:10:00	B207045	Silver	ND	0.0200	0.0400	mg/L	2	2052501-01	0.0208	NA	NA		NA	NA	20
B207045-DUP2	Dup	Water	05/22/2012 00:00:00	05/25/2012 16:10:00	B207045	Sodium	0.478	0.0200	0.0400	mg/L	2	2052501-01	0.455	NA	NA	4.91	NA	NA	20
B207045-DUP2	Dup	Water	05/22/2012 00:00:00	05/25/2012 16:10:00	B207045	Thallium	ND	0.0200	0.0400	mg/L	2	2052501-01	ND	NA	NA		NA	NA	20
B207045-DUP2	Dup	Water	05/22/2012 00:00:00	05/25/2012 16:10:00	B207045	Arsenic	ND	0.0200	0.0400	mg/L	2	2052501-01	ND	NA	NA		NA	NA	20
B207045-DUP2	Dup	Water	05/22/2012 00:00:00	05/25/2012 16:10:00	B207045	Vanadium	ND	0.0200	0.0400	mg/L	2	2052501-01	ND	NA	NA		NA	NA	20
B207045-DUP2	Dup	Water	05/22/2012 00:00:00	05/25/2012 16:10:00	B207045	Zinc	0.0589	0.0200	0.0400	mg/L	2	2052501-01	0.0922	NA	NA	44.1	NA	NA	20
B207045-DUP2	Dup	Water	05/22/2012 00:00:00	05/25/2012 16:10:00	B207045	Barium	ND	0.0200	0.0400	mg/L	2	2052501-01	ND	NA	NA		NA	NA	20
B207045-DUP2	Dup	Water	05/22/2012 00:00:00	05/25/2012 16:10:00	B207045	Beryllium	ND	0.0200	0.0400	mg/L	2	2052501-01	ND	NA	NA		NA	NA	20
B207045-DUP2	Dup	Water	05/22/2012 00:00:00	05/25/2012 16:10:00	B207045	Cadmium	ND	0.0200	0.0400	mg/L	2	2052501-01	ND	NA	NA		NA	NA	20
B207045-DUP2	Dup	Water	05/22/2012 00:00:00	05/25/2012 16:10:00	B207045	Calcium	0.275	0.0200	0.0400	mg/L	2	2052501-01	0.248	NA	NA	10.4	NA	NA	20
B207045-DUP2	Dup	Water	05/22/2012 00:00:00	05/25/2012 16:10:00	B207045	Chromium	ND	0.0200	0.0400	mg/L	2	2052501-01	ND	NA	NA	NA	NA	NA	20
B207045-MS1	Matrix Spike	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Aluminum	1.98	0.0200	0.0400	mg/L	2	2051001-01	0.0552	2.000	96.4	NA	120	80	NA
B207045-MS1	Matrix Spike	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Cobalt	2.00	0.0200	0.0400	mg/L	2	2051001-01	ND	2.000	99.9	NA	120	80	NA
B207045-MS1	Matrix Spike	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Copper	2.05	0.0200	0.0400	mg/L	2	2051001-01	0.0488	2.000	100	NA	120	80	NA
B207045-MS1	Matrix Spike	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Iron	2.40	0.0200	0.0400	mg/L	2	2051001-01	0.333	2.000	103	NA	120	80	NA

SAMPID	TYPE	MATRIX	PREPDATE	ANADATE	BATCH	ANALYTE	RESULT	DL	RL	UNITS	DIL	SORC ID	SORC RES	SPIKE LVL	REC	RPD	U CL	L CL	RPDCL
B207045-MS1	Matrix Spike	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Lead	1.97	0.0200	0.0400	mg/L	2	2051001-01	0.0240	2.000	97.1	NA	120	80	NA
B207045-MS1	Matrix Spike	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Magnesium	2.12	0.0200	0.0400	mg/L	2	2051001-01	0.147	2.000	98.8	NA	120	80	NA
B207045-MS1	Matrix Spike	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Manganese	2.06	0.0200	0.0400	mg/L	2	2051001-01	0.0241	2.000	102	NA	120	80	NA
B207045-MS1	Matrix Spike	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Nickel	2.12	0.0200	0.0400	mg/L	2	2051001-01	0.109	2.000	100	NA	120	80	NA
B207045-MS1	Matrix Spike	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Phosphorus	1.84	0.0200	0.0400	mg/L	2	2051001-01	ND	2.000	91.8	NA	120	80	NA
B207045-MS1	Matrix Spike	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Potassium	2.10	0.0200	0.0400	mg/L	2	2051001-01	0.390	2.000	85.7	NA	120	80	NA
B207045-MS1	Matrix Spike	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Antimony	1.85	0.0200	0.0400	mg/L	2	2051001-01	0.0285	2.000	91.2	NA	120	80	NA
B207045-MS1	Matrix Spike	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Selenium	1.82	0.0200	0.0400	mg/L	2	2051001-01	ND	2.000	91.2	NA	120	80	NA
B207045-MS1	Matrix Spike	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Silver	1.88	0.0200	0.0400	mg/L	2	2051001-01	0.0220	2.000	93.0	NA	120	80	NA
B207045-MS1	Matrix Spike	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Sodium	2.05	0.0200	0.0400	mg/L	2	2051001-01	0.177	2.000	93.7	NA	120	80	NA
B207045-MS1	Matrix Spike	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Thallium	1.96	0.0200	0.0400	mg/L	2	2051001-01	ND	2.000	98.2	NA	120	80	NA
B207045-MS1	Matrix Spike	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Arsenic	1.88	0.0200	0.0400	mg/L	2	2051001-01	ND	2.000	94.2	NA	120	80	NA
B207045-MS1	Matrix Spike	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Vanadium	1.95	0.0200	0.0400	mg/L	2	2051001-01	ND	2.000	97.3	NA	120	80	NA
B207045-MS1	Matrix Spike	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Zinc	1.95	0.0200	0.0400	mg/L	2	2051001-01	0.0757	2.000	93.6	NA	120	80	NA
B207045-MS1	Matrix Spike	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Barium	1.93	0.0200	0.0400	mg/L	2	2051001-01	ND	2.000	96.6	NA	120	80	NA
B207045-MS1	Matrix Spike	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Beryllium	1.95	0.0200	0.0400	mg/L	2	2051001-01	ND	2.000	97.6	NA	120	80	NA
B207045-MS1	Matrix Spike	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Cadmium	1.96	0.0200	0.0400	mg/L	2	2051001-01	0.0315	2.000	96.4	NA	120	80	NA
B207045-MS1	Matrix Spike	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Calcium	2.28	0.0200	0.0400	mg/L	2	2051001-01	0.278	2.000	99.9	NA	120	80	NA

SAMPID	TYPE	MATRIX	PREPDATE	ANADATE	BATCH	ANALYTE	RESULT	DL	RL	UNITS	DIL	SORC ID	SORC RES	SPIKE LVL	REC	RPD	U CL	L CL	RPDCL
B207045-MS1	Matrix Spike	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Chromium	2.13	0.0200	0.0400	mg/L	2	2051001-01	0.0927	2.000	102	NA	120	80	NA
B207045-MS2	Matrix Spike	Water	05/22/2012 00:00:00	05/25/2012 16:10:00	B207045	Aluminum	2.09	0.0200	0.0400	mg/L	2	2052501-01	0.0354	2.000	103	NA	120	80	NA
B207045-MS2	Matrix Spike	Water	05/22/2012 00:00:00	05/25/2012 16:10:00	B207045	Cobalt	2.06	0.0200	0.0400	mg/L	2	2052501-01	ND	2.000	103	NA	120	80	NA
B207045-MS2	Matrix Spike	Water	05/22/2012 00:00:00	05/25/2012 16:10:00	B207045	Copper	2.15	0.0200	0.0400	mg/L	2	2052501-01	0.0653	2.000	104	NA	120	80	NA
B207045-MS2	Matrix Spike	Water	05/22/2012 00:00:00	05/25/2012 16:10:00	B207045	Iron	2.23	0.0200	0.0400	mg/L	2	2052501-01	0.0801	2.000	108	NA	120	80	NA
B207045-MS2	Matrix Spike	Water	05/22/2012 00:00:00	05/25/2012 16:10:00	B207045	Lead	2.06	0.0200	0.0400	mg/L	2	2052501-01	0.196	2.000	93.2	NA	120	80	NA
B207045-MS2	Matrix Spike	Water	05/22/2012 00:00:00	05/25/2012 16:10:00	B207045	Magnesium	2.25	0.0200	0.0400	mg/L	2	2052501-01	0.135	2.000	106	NA	120	80	NA
B207045-MS2	Matrix Spike	Water	05/22/2012 00:00:00	05/25/2012 16:10:00	B207045	Manganese	2.06	0.0200	0.0400	mg/L	2	2052501-01	ND	2.000	103	NA	120	80	NA
B207045-MS2	Matrix Spike	Water	05/22/2012 00:00:00	05/25/2012 16:10:00	B207045	Nickel	2.07	0.0200	0.0400	mg/L	2	2052501-01	ND	2.000	103	NA	120	80	NA
B207045-MS2	Matrix Spike	Water	05/22/2012 00:00:00	05/25/2012 16:10:00	B207045	Phosphorus	1.94	0.0200	0.0400	mg/L	2	2052501-01	0.0708	2.000	93.2	NA	120	80	NA
B207045-MS2	Matrix Spike	Water	05/22/2012 00:00:00	05/25/2012 16:10:00	B207045	Potassium	2.43	0.0200	0.0400	mg/L	2	2052501-01	0.488	2.000	96.9	NA	120	80	NA
B207045-MS2	Matrix Spike	Water	05/22/2012 00:00:00	05/25/2012 16:10:00	B207045	Antimony	1.97	0.0200	0.0400	mg/L	2	2052501-01	0.152	2.000	90.8	NA	120	80	NA
B207045-MS2	Matrix Spike	Water	05/22/2012 00:00:00	05/25/2012 16:10:00	B207045	Selenium	1.92	0.0200	0.0400	mg/L	2	2052501-01	ND	2.000	96.1	NA	120	80	NA
B207045-MS2	Matrix Spike	Water	05/22/2012 00:00:00	05/25/2012 16:10:00	B207045	Silver	1.97	0.0200	0.0400	mg/L	2	2052501-01	0.0208	2.000	97.6	NA	120	80	NA
B207045-MS2	Matrix Spike	Water	05/22/2012 00:00:00	05/25/2012 16:10:00	B207045	Sodium	2.48	0.0200	0.0400	mg/L	2	2052501-01	0.455	2.000	101	NA	120	80	NA
B207045-MS2	Matrix Spike	Water	05/22/2012 00:00:00	05/25/2012 16:10:00	B207045	Thallium	2.05	0.0200	0.0400	mg/L	2	2052501-01	ND	2.000	102	NA	120	80	NA
B207045-MS2	Matrix Spike	Water	05/22/2012 00:00:00	05/25/2012 16:10:00	B207045	Arsenic	1.94	0.0200	0.0400	mg/L	2	2052501-01	ND	2.000	97.2	NA	120	80	NA
B207045-MS2	Matrix Spike	Water	05/22/2012 00:00:00	05/25/2012 16:10:00	B207045	Vanadium	2.01	0.0200	0.0400	mg/L	2	2052501-01	ND	2.000	100	NA	120	80	NA

SAMPID	TYPE	MATRIX	PREPDATE	ANADATE	BATCH	ANALYTE	RESULT	DL	RL	UNITS	DIL	SORC ID	SORC RES	SPIKE LVL	REC	RPD	U CL	L CL	RPDCL
B207045-MS2	Matrix Spike	Water	05/22/2012 00:00:00	05/25/2012 16:10:00	B207045	Zinc	2.02	0.0200	0.0400	mg/L	2	20525 01-01	0.0922	2.000	96.4	NA	120	80	NA
B207045-MS2	Matrix Spike	Water	05/22/2012 00:00:00	05/25/2012 16:10:00	B207045	Barium	2.03	0.0200	0.0400	mg/L	2	20525 01-01	ND	2.000	101	NA	120	80	NA
B207045-MS2	Matrix Spike	Water	05/22/2012 00:00:00	05/25/2012 16:10:00	B207045	Beryllium	2.07	0.0200	0.0400	mg/L	2	20525 01-01	ND	2.000	104	NA	120	80	NA
B207045-MS2	Matrix Spike	Water	05/22/2012 00:00:00	05/25/2012 16:10:00	B207045	Cadmium	2.03	0.0200	0.0400	mg/L	2	20525 01-01	ND	2.000	102	NA	120	80	NA
B207045-MS2	Matrix Spike	Water	05/22/2012 00:00:00	05/25/2012 16:10:00	B207045	Calcium	2.34	0.0200	0.0400	mg/L	2	20525 01-01	0.248	2.000	104	NA	120	80	NA
B207045-MS2	Matrix Spike	Water	05/22/2012 00:00:00	05/25/2012 16:10:00	B207045	Chromium	2.10	0.0200	0.0400	mg/L	2	20525 01-01	ND	2.000	105	NA	120	80	NA
B205045-BLK1	Blank	Soil/Sed	05/17/2012 08:16:00	05/17/2012 12:00:00	B205045	Aluminum	ND	0.0100	0.0200	mg/kg	1	NA	NA	NA	NA	NA	NA	NA	NA
B205045-BLK1	Blank	Soil/Sed	05/17/2012 08:16:00	05/17/2012 12:00:00	B205045	Copper	0.0648	0.0100	0.0200	mg/kg	1	NA	NA	NA	NA	NA	NA	NA	NA
B205045-BLK1	Blank	Soil/Sed	05/17/2012 08:16:00	05/17/2012 12:00:00	B205045	Iron	ND	0.0100	0.0200	mg/kg	1	NA	NA	NA	NA	NA	NA	NA	NA
B205045-BLK1	Blank	Soil/Sed	05/17/2012 08:16:00	05/17/2012 12:00:00	B205045	Lead	0.171	0.0100	0.0200	mg/kg	1	NA	NA	NA	NA	NA	NA	NA	NA
B205045-BLK1	Blank	Soil/Sed	05/17/2012 08:16:00	05/17/2012 12:00:00	B205045	Magnesium	ND	0.0100	0.0200	mg/kg	1	NA	NA	NA	NA	NA	NA	NA	NA
B205045-BLK1	Blank	Soil/Sed	05/17/2012 08:16:00	05/17/2012 12:00:00	B205045	Manganese	0.0142	0.0100	0.0200	mg/kg	1	NA	NA	NA	NA	NA	NA	NA	NA
B205045-BLK1	Blank	Soil/Sed	05/17/2012 08:16:00	05/17/2012 12:00:00	B205045	Nickel	ND	0.0100	0.0200	mg/kg	1	NA	NA	NA	NA	NA	NA	NA	NA
B205045-BLK1	Blank	Soil/Sed	05/17/2012 08:16:00	05/17/2012 12:00:00	B205045	Phosphorus	ND	0.0100	0.0200	mg/kg	1	NA	NA	NA	NA	NA	NA	NA	NA
B205045-BLK1	Blank	Soil/Sed	05/17/2012 08:16:00	05/17/2012 12:00:00	B205045	Potassium	ND	0.0100	0.0200	mg/kg	1	NA	NA	NA	NA	NA	NA	NA	NA
B205045-BLK1	Blank	Soil/Sed	05/17/2012 08:16:00	05/17/2012 12:00:00	B205045	Selenium	0.136	0.0100	0.0200	mg/kg	1	NA	NA	NA	NA	NA	NA	NA	NA
B205045-BLK1	Blank	Soil/Sed	05/17/2012 08:16:00	05/17/2012 12:00:00	B205045	Antimony	0.0748	0.0100	0.0200	mg/kg	1	NA	NA	NA	NA	NA	NA	NA	NA
B205045-BLK1	Blank	Soil/Sed	05/17/2012 08:16:00	05/17/2012 12:00:00	B205045	Silver	0.0369	0.0100	0.0200	mg/kg	1	NA	NA	NA	NA	NA	NA	NA	NA

SAMPID	TYPE	MATRIX	PREPDATE	ANADATE	BATCH	ANALYTE	RESULT	DL	RL	UNITS	DIL	SORC ID	SORC RES	SPIKE LVL	REC	RPD	U CL	L CL	RPDCL
B205045-BLK1	Blank	Soil/Sed	05/17/2012 08:16:00	05/17/2012 12:00:00	B205045	Sodium	ND	0.0100	0.0200	mg/kg	1	NA	NA	NA	NA	NA	NA	NA	NA
B205045-BLK1	Blank	Soil/Sed	05/17/2012 08:16:00	05/17/2012 12:00:00	B205045	Thallium	0.0326	0.0100	0.0200	mg/kg	1	NA	NA	NA	NA	NA	NA	NA	NA
B205045-BLK1	Blank	Soil/Sed	05/17/2012 08:16:00	05/17/2012 12:00:00	B205045	Vanadium	ND	0.0100	0.0200	mg/kg	1	NA	NA	NA	NA	NA	NA	NA	NA
B205045-BLK1	Blank	Soil/Sed	05/17/2012 08:16:00	05/17/2012 12:00:00	B205045	Zinc	0.0936	0.0100	0.0200	mg/kg	1	NA	NA	NA	NA	NA	NA	NA	NA
B205045-BLK1	Blank	Soil/Sed	05/17/2012 08:16:00	05/17/2012 12:00:00	B205045	Arsenic	0.0517	0.0100	0.0200	mg/kg	1	NA	NA	NA	NA	NA	NA	NA	NA
B205045-BLK1	Blank	Soil/Sed	05/17/2012 08:16:00	05/17/2012 12:00:00	B205045	Barium	ND	0.0100	0.0200	mg/kg	1	NA	NA	NA	NA	NA	NA	NA	NA
B205045-BLK1	Blank	Soil/Sed	05/17/2012 08:16:00	05/17/2012 12:00:00	B205045	Beryllium	ND	0.0100	0.0200	mg/kg	1	NA	NA	NA	NA	NA	NA	NA	NA
B205045-BLK1	Blank	Soil/Sed	05/17/2012 08:16:00	05/17/2012 12:00:00	B205045	Cadmium	0.0311	0.0100	0.0200	mg/kg	1	NA	NA	NA	NA	NA	NA	NA	NA
B205045-BLK1	Blank	Soil/Sed	05/17/2012 08:16:00	05/17/2012 12:00:00	B205045	Calcium	ND	0.0100	0.0200	mg/kg	1	NA	NA	NA	NA	NA	NA	NA	NA
B205045-BLK1	Blank	Soil/Sed	05/17/2012 08:16:00	05/17/2012 12:00:00	B205045	Chromium	0.0115	0.0100	0.0200	mg/kg	1	NA	NA	NA	NA	NA	NA	NA	NA
B205045-BLK1	Blank	Soil/Sed	05/17/2012 08:16:00	05/17/2012 12:00:00	B205045	Cobalt	ND	0.0100	0.0200	mg/kg	1	NA	NA	NA	NA	NA	NA	NA	NA
B205045-BS1	LCS	Soil/Sed	05/17/2012 08:16:00	05/17/2012 12:00:00	B205045	Aluminum	250	0.0100	0.0200	mg/kg	1	NA	NA	250.0	100	NA	120	80	NA
B205045-BS1	LCS	Soil/Sed	05/17/2012 08:16:00	05/17/2012 12:00:00	B205045	Copper	252	0.0100	0.0200	mg/kg	1	NA	NA	250.0	101	NA	120	80	NA
B205045-BS1	LCS	Soil/Sed	05/17/2012 08:16:00	05/17/2012 12:00:00	B205045	Iron	264	0.0100	0.0200	mg/kg	1	NA	NA	250.0	105	NA	120	80	NA
B205045-BS1	LCS	Soil/Sed	05/17/2012 08:16:00	05/17/2012 12:00:00	B205045	Lead	251	0.0100	0.0200	mg/kg	1	NA	NA	250.0	100	NA	120	80	NA
B205045-BS1	LCS	Soil/Sed	05/17/2012 08:16:00	05/17/2012 12:00:00	B205045	Magnesium	256	0.0100	0.0200	mg/kg	1	NA	NA	250.0	102	NA	120	80	NA
B205045-BS1	LCS	Soil/Sed	05/17/2012 08:16:00	05/17/2012 12:00:00	B205045	Manganese	251	0.0100	0.0200	mg/kg	1	NA	NA	250.0	100	NA	120	80	NA
B205045-BS1	LCS	Soil/Sed	05/17/2012 08:16:00	05/17/2012 12:00:00	B205045	Nickel	253	0.0100	0.0200	mg/kg	1	NA	NA	250.0	101	NA	120	80	NA

SAMPID	TYPE	MATRIX	PREPDATE	ANADATE	BATCH	ANALYTE	RESULT	DL	RL	UNITS	DIL	SORC ID	SORC RES	SPIKE LVL	REC	RPD	U CL	L CL	RPDCL
B205045-BS1	LCS	Soil/Sed	05/17/2012 08:16:00	05/17/2012 12:00:00	B205045	Phosphorus	246	0.0100	0.0200	mg/kg	1	NA	NA	250.0	98.2	NA	120	80	NA
B205045-BS1	LCS	Soil/Sed	05/17/2012 08:16:00	05/17/2012 12:00:00	B205045	Potassium	242	0.0100	0.0200	mg/kg	1	NA	NA	250.0	96.6	NA	120	80	NA
B205045-BS1	LCS	Soil/Sed	05/17/2012 08:16:00	05/17/2012 12:00:00	B205045	Selenium	245	0.0100	0.0200	mg/kg	1	NA	NA	250.0	98.1	NA	120	80	NA
B205045-BS1	LCS	Soil/Sed	05/17/2012 08:16:00	05/17/2012 12:00:00	B205045	Antimony	242	0.0100	0.0200	mg/kg	1	NA	NA	250.0	97.0	NA	120	80	NA
B205045-BS1	LCS	Soil/Sed	05/17/2012 08:16:00	05/17/2012 12:00:00	B205045	Silver	245	0.0100	0.0200	mg/kg	1	NA	NA	250.0	98.0	NA	120	80	NA
B205045-BS1	LCS	Soil/Sed	05/17/2012 08:16:00	05/17/2012 12:00:00	B205045	Sodium	247	0.0100	0.0200	mg/kg	1	NA	NA	250.0	98.9	NA	120	80	NA
B205045-BS1	LCS	Soil/Sed	05/17/2012 08:16:00	05/17/2012 12:00:00	B205045	Thallium	254	0.0100	0.0200	mg/kg	1	NA	NA	250.0	101	NA	120	80	NA
B205045-BS1	LCS	Soil/Sed	05/17/2012 08:16:00	05/17/2012 12:00:00	B205045	Vanadium	243	0.0100	0.0200	mg/kg	1	NA	NA	250.0	97.3	NA	120	80	NA
B205045-BS1	LCS	Soil/Sed	05/17/2012 08:16:00	05/17/2012 12:00:00	B205045	Zinc	257	0.0100	0.0200	mg/kg	1	NA	NA	250.0	103	NA	120	80	NA
B205045-BS1	LCS	Soil/Sed	05/17/2012 08:16:00	05/17/2012 12:00:00	B205045	Arsenic	242	0.0100	0.0200	mg/kg	1	NA	NA	250.0	96.6	NA	120	80	NA
B205045-BS1	LCS	Soil/Sed	05/17/2012 08:16:00	05/17/2012 12:00:00	B205045	Barium	243	0.0100	0.0200	mg/kg	1	NA	NA	250.0	97.0	NA	120	80	NA
B205045-BS1	LCS	Soil/Sed	05/17/2012 08:16:00	05/17/2012 12:00:00	B205045	Beryllium	248	0.0100	0.0200	mg/kg	1	NA	NA	250.0	99.4	NA	120	80	NA
B205045-BS1	LCS	Soil/Sed	05/17/2012 08:16:00	05/17/2012 12:00:00	B205045	Cadmium	198	0.0100	0.0200	mg/kg	1	NA	NA	250.0	79.3	NA	120	80	NA
B205045-BS1	LCS	Soil/Sed	05/17/2012 08:16:00	05/17/2012 12:00:00	B205045	Calcium	253	0.0100	0.0200	mg/kg	1	NA	NA	250.0	101	NA	120	80	NA
B205045-BS1	LCS	Soil/Sed	05/17/2012 08:16:00	05/17/2012 12:00:00	B205045	Chromium	251	0.0100	0.0200	mg/kg	1	NA	NA	250.0	100	NA	120	80	NA
B205045-BS1	LCS	Soil/Sed	05/17/2012 08:16:00	05/17/2012 12:00:00	B205045	Cobalt	251	0.0100	0.0200	mg/kg	1	NA	NA	250.0	101	NA	120	80	NA
B205045-DUP1	Dup	Soil/Sed	05/17/2012 08:16:00	05/17/2012 12:00:00	B205045	Aluminum	5900000000	0.0200	0.0400	mg/kg	2	2051702-01	5920000000	NA	NA	0.307	NA	NA	20
B205045-DUP1	Dup	Soil/Sed	05/17/2012 08:16:00	05/17/2012 12:00:00	B205045	Copper	22200000	0.0200	0.0400	mg/kg	2	2051702-01	22300000	NA	NA	0.562	NA	NA	20

SAMPID	TYPE	MATRIX	PREPDATE	ANADATE	BATCH	ANALYTE	RESULT	DL	RL	UNITS	DIL	SORC ID	SORC RES	SPIKE LVL	REC	RPD	U CL	L CL	RPDCL
B205045-DUP1	Dup	Soil/Sed	05/17/2012 08:16:00	05/17/2012 12:00:00	B205045	Iron	5650000000	0.0200	0.0400	mg/kg	2	2051702-01	5660000000	NA	NA	0.279	NA	NA	20
B205045-DUP1	Dup	Soil/Sed	05/17/2012 08:16:00	05/17/2012 12:00:00	B205045	Lead	179000000	0.0200	0.0400	mg/kg	2	2051702-01	179000000	NA	NA	0.0122	NA	NA	20
B205045-DUP1	Dup	Soil/Sed	05/17/2012 08:16:00	05/17/2012 12:00:00	B205045	Magnesium	595000000	0.0200	0.0400	mg/kg	2	2051702-01	596000000	NA	NA	0.293	NA	NA	20
B205045-DUP1	Dup	Soil/Sed	05/17/2012 08:16:00	05/17/2012 12:00:00	B205045	Manganese	92300000	0.0200	0.0400	mg/kg	2	2051702-01	92900000	NA	NA	0.579	NA	NA	20
B205045-DUP1	Dup	Soil/Sed	05/17/2012 08:16:00	05/17/2012 12:00:00	B205045	Nickel	11000000	0.0200	0.0400	mg/kg	2	2051702-01	11000000	NA	NA	0.345	NA	NA	20
B205045-DUP1	Dup	Soil/Sed	05/17/2012 08:16:00	05/17/2012 12:00:00	B205045	Phosphorus	294000000	0.0200	0.0400	mg/kg	2	2051702-01	294000000	NA	NA	0.00619	NA	NA	20
B205045-DUP1	Dup	Soil/Sed	05/17/2012 08:16:00	05/17/2012 12:00:00	B205045	Potassium	479000000	0.0200	0.0400	mg/kg	2	2051702-01	478000000	NA	NA	0.287	NA	NA	20
B205045-DUP1	Dup	Soil/Sed	05/17/2012 08:16:00	05/17/2012 12:00:00	B205045	Selenium	2870000	0.0200	0.0400	mg/kg	2	2051702-01	2940000	NA	NA	2.50	NA	NA	20
B205045-DUP1	Dup	Soil/Sed	05/17/2012 08:16:00	05/17/2012 12:00:00	B205045	Antimony	3390000	0.0200	0.0400	mg/kg	2	2051702-01	4350000	NA	NA	24.8	NA	NA	20
B205045-DUP1	Dup	Soil/Sed	05/17/2012 08:16:00	05/17/2012 12:00:00	B205045	Silver	309000	0.0200	0.0400	mg/kg	2	2051702-01	453000	NA	NA	37.8	NA	NA	20
B205045-DUP1	Dup	Soil/Sed	05/17/2012 08:16:00	05/17/2012 12:00:00	B205045	Sodium	54600000	0.0200	0.0400	mg/kg	2	2051702-01	54800000	NA	NA	0.284	NA	NA	20
B205045-DUP1	Dup	Soil/Sed	05/17/2012 08:16:00	05/17/2012 12:00:00	B205045	Thallium	3030000	0.0200	0.0400	mg/kg	2	2051702-01	4280000	NA	NA	34.3	NA	NA	20
B205045-DUP1	Dup	Soil/Sed	05/17/2012 08:16:00	05/17/2012 12:00:00	B205045	Vanadium	21500000	0.0200	0.0400	mg/kg	2	2051702-01	21500000	NA	NA	0.154	NA	NA	20
B205045-DUP1	Dup	Soil/Sed	05/17/2012 08:16:00	05/17/2012 12:00:00	B205045	Zinc	27300000	0.0200	0.0400	mg/kg	2	2051702-01	27600000	NA	NA	1.03	NA	NA	20
B205045-DUP1	Dup	Soil/Sed	05/17/2012 08:16:00	05/17/2012 12:00:00	B205045	Arsenic	1370000	0.0200	0.0400	mg/kg	2	2051702-01	1530000	NA	NA	11.2	NA	NA	20
B205045-DUP1	Dup	Soil/Sed	05/17/2012 08:16:00	05/17/2012 12:00:00	B205045	Barium	45000000	0.0200	0.0400	mg/kg	2	2051702-01	45200000	NA	NA	0.447	NA	NA	20
B205045-DUP1	Dup	Soil/Sed	05/17/2012 08:16:00	05/17/2012 12:00:00	B205045	Beryllium	157000	0.0200	0.0400	mg/kg	2	2051702-01	161000	NA	NA	3.05	NA	NA	20
B205045-DUP1	Dup	Soil/Sed	05/17/2012 08:16:00	05/17/2012 12:00:00	B205045	Cadmium	2080000	0.0200	0.0400	mg/kg	2	2051702-01	2400000	NA	NA	14.0	NA	NA	20

SAMPID	TYPE	MATRIX	PREPDATE	ANADATE	BATCH	ANALYTE	RESULT	DL	RL	UNITS	DIL	SORC ID	SORC RES	SPIKE LVL	REC	RPD	U CL	L CL	RPDCL
B205045-DUP1	Dup	Soil/Sed	05/17/2012 08:16:00	05/17/2012 12:00:00	B205045	Calcium	1960000000	0.0200	0.0400	mg/kg	2	2051702-01	1960000000	NA	NA	0.0755	NA	NA	20
B205045-DUP1	Dup	Soil/Sed	05/17/2012 08:16:00	05/17/2012 12:00:00	B205045	Chromium	7190000	0.0200	0.0400	mg/kg	2	2051702-01	7210000	NA	NA	0.187	NA	NA	20
B205045-DUP1	Dup	Soil/Sed	05/17/2012 08:16:00	05/17/2012 12:00:00	B205045	Cobalt	2390000	0.0200	0.0400	mg/kg	2	2051702-01	2390000	NA	NA	0.131	NA	NA	20
B205045-MS1	Matrix Spike	Soil/Sed	05/17/2012 08:16:00	05/17/2012 12:00:00	B205045	Aluminum	6010000000	0.0200	0.0400	mg/kg	2	2051702-01	5920000000	2.000E8	48.0	NA	120	80	NA
B205045-MS1	Matrix Spike	Soil/Sed	05/17/2012 08:16:00	05/17/2012 12:00:00	B205045	Copper	237000000	0.0200	0.0400	mg/kg	2	2051702-01	22300000	2.000E8	107	NA	120	80	NA
B205045-MS1	Matrix Spike	Soil/Sed	05/17/2012 08:16:00	05/17/2012 12:00:00	B205045	Iron	5770000000	0.0200	0.0400	mg/kg	2	2051702-01	5660000000	2.000E8	54.6	NA	120	80	NA
B205045-MS1	Matrix Spike	Soil/Sed	05/17/2012 08:16:00	05/17/2012 12:00:00	B205045	Lead	371000000	0.0200	0.0400	mg/kg	2	2051702-01	179000000	2.000E8	96.0	NA	120	80	NA
B205045-MS1	Matrix Spike	Soil/Sed	05/17/2012 08:16:00	05/17/2012 12:00:00	B205045	Magnesium	781000000	0.0200	0.0400	mg/kg	2	2051702-01	596000000	2.000E8	92.4	NA	120	80	NA
B205045-MS1	Matrix Spike	Soil/Sed	05/17/2012 08:16:00	05/17/2012 12:00:00	B205045	Manganese	288000000	0.0200	0.0400	mg/kg	2	2051702-01	92900000	2.000E8	97.4	NA	120	80	NA
B205045-MS1	Matrix Spike	Soil/Sed	05/17/2012 08:16:00	05/17/2012 12:00:00	B205045	Nickel	210000000	0.0200	0.0400	mg/kg	2	2051702-01	11000000	2.000E8	99.7	NA	120	80	NA
B205045-MS1	Matrix Spike	Soil/Sed	05/17/2012 08:16:00	05/17/2012 12:00:00	B205045	Phosphorus	485000000	0.0200	0.0400	mg/kg	2	2051702-01	294000000	2.000E8	95.5	NA	120	80	NA
B205045-MS1	Matrix Spike	Soil/Sed	05/17/2012 08:16:00	05/17/2012 12:00:00	B205045	Potassium	649000000	0.0200	0.0400	mg/kg	2	2051702-01	478000000	2.000E8	85.4	NA	120	80	NA
B205045-MS1	Matrix Spike	Soil/Sed	05/17/2012 08:16:00	05/17/2012 12:00:00	B205045	Selenium	202000000	0.0200	0.0400	mg/kg	2	2051702-01	2940000	2.000E8	99.7	NA	120	80	NA
B205045-MS1	Matrix Spike	Soil/Sed	05/17/2012 08:16:00	05/17/2012 12:00:00	B205045	Antimony	193000000	0.0200	0.0400	mg/kg	2	2051702-01	4350000	2.000E8	94.1	NA	120	80	NA
B205045-MS1	Matrix Spike	Soil/Sed	05/17/2012 08:16:00	05/17/2012 12:00:00	B205045	Silver	191000000	0.0200	0.0400	mg/kg	2	2051702-01	453000	2.000E8	95.3	NA	120	80	NA
B205045-MS1	Matrix Spike	Soil/Sed	05/17/2012 08:16:00	05/17/2012 12:00:00	B205045	Sodium	249000000	0.0200	0.0400	mg/kg	2	2051702-01	54800000	2.000E8	97.1	NA	120	80	NA
B205045-MS1	Matrix Spike	Soil/Sed	05/17/2012 08:16:00	05/17/2012 12:00:00	B205045	Thallium	202000000	0.0200	0.0400	mg/kg	2	2051702-01	4280000	2.000E8	98.7	NA	120	80	NA
B205045-MS1	Matrix Spike	Soil/Sed	05/17/2012 08:16:00	05/17/2012 12:00:00	B205045	Vanadium	215000000	0.0200	0.0400	mg/kg	2	2051702-01	21500000	2.000E8	96.5	NA	120	80	NA

SAMPID	TYPE	MATRIX	PREPDATE	ANADATE	BATCH	ANALYTE	RESULT	DL	RL	UNITS	DIL	SORC ID	SORC RES	SPIKE LVL	REC	RPD	U CL	L CL	RPDCL
B205045-MS1	Matrix Spike	Soil/Sed	05/17/2012 08:16:00	05/17/2012 12:00:00	B205045	Zinc	223000000	0.0200	0.0400	mg/kg	2	2051702-01	27600000	2.000E8	97.8	NA	120	80	NA
B205045-MS1	Matrix Spike	Soil/Sed	05/17/2012 08:16:00	05/17/2012 12:00:00	B205045	Arsenic	198000000	0.0200	0.0400	mg/kg	2	2051702-01	1530000	2.000E8	98.4	NA	120	80	NA
B205045-MS1	Matrix Spike	Soil/Sed	05/17/2012 08:16:00	05/17/2012 12:00:00	B205045	Barium	241000000	0.0200	0.0400	mg/kg	2	2051702-01	45200000	2.000E8	97.7	NA	120	80	NA
B205045-MS1	Matrix Spike	Soil/Sed	05/17/2012 08:16:00	05/17/2012 12:00:00	B205045	Beryllium	201000000	0.0200	0.0400	mg/kg	2	2051702-01	161000	2.000E8	100	NA	120	80	NA
B205045-MS1	Matrix Spike	Soil/Sed	05/17/2012 08:16:00	05/17/2012 12:00:00	B205045	Cadmium	201000000	0.0200	0.0400	mg/kg	2	2051702-01	2400000	2.000E8	99.4	NA	120	80	NA
B205045-MS1	Matrix Spike	Soil/Sed	05/17/2012 08:16:00	05/17/2012 12:00:00	B205045	Calcium	2130000000	0.0200	0.0400	mg/kg	2	2051702-01	1960000000	2.000E8	85.5	NA	120	80	NA
B205045-MS1	Matrix Spike	Soil/Sed	05/17/2012 08:16:00	05/17/2012 12:00:00	B205045	Chromium	206000000	0.0200	0.0400	mg/kg	2	2051702-01	7210000	2.000E8	99.3	NA	120	80	NA
B205045-MS1	Matrix Spike	Soil/Sed	05/17/2012 08:16:00	05/17/2012 12:00:00	B205045	Cobalt	202000000	0.0200	0.0400	mg/kg	2	2051702-01	2390000	2.000E8	99.7	NA	120	80	NA
B205048-BLK1	Blank	Soil/Sed	05/17/2012 14:08:00	05/17/2012 16:00:00	B205048	Aluminum	ND	2.00	4.00	mg/kg	2	NA	NA	NA	NA	NA	NA	NA	NA
B205048-BLK1	Blank	Soil/Sed	05/17/2012 14:08:00	05/17/2012 16:00:00	B205048	Copper	ND	2.00	4.00	mg/kg	2	NA	NA	NA	NA	NA	NA	NA	NA
B205048-BLK1	Blank	Soil/Sed	05/17/2012 14:08:00	05/17/2012 16:00:00	B205048	Iron	ND	2.00	4.00	mg/kg	2	NA	NA	NA	NA	NA	NA	NA	NA
B205048-BLK1	Blank	Soil/Sed	05/17/2012 14:08:00	05/17/2012 16:00:00	B205048	Lead	ND	2.00	4.00	mg/kg	2	NA	NA	NA	NA	NA	NA	NA	NA
B205048-BLK1	Blank	Soil/Sed	05/17/2012 14:08:00	05/17/2012 16:00:00	B205048	Magnesium	ND	2.00	4.00	mg/kg	2	NA	NA	NA	NA	NA	NA	NA	NA
B205048-BLK1	Blank	Soil/Sed	05/17/2012 14:08:00	05/17/2012 16:00:00	B205048	Manganese	ND	2.00	4.00	mg/kg	2	NA	NA	NA	NA	NA	NA	NA	NA
B205048-BLK1	Blank	Soil/Sed	05/17/2012 14:08:00	05/17/2012 16:00:00	B205048	Nickel	ND	2.00	4.00	mg/kg	2	NA	NA	NA	NA	NA	NA	NA	NA
B205048-BLK1	Blank	Soil/Sed	05/17/2012 14:08:00	05/17/2012 16:00:00	B205048	Phosphorus	ND	2.00	4.00	mg/kg	2	NA	NA	NA	NA	NA	NA	NA	NA
B205048-BLK1	Blank	Soil/Sed	05/17/2012 14:08:00	05/17/2012 16:00:00	B205048	Potassium	ND	2.00	4.00	mg/kg	2	NA	NA	NA	NA	NA	NA	NA	NA
B205048-BLK1	Blank	Soil/Sed	05/17/2012 14:08:00	05/17/2012 16:00:00	B205048	Selenium	ND	2.00	4.00	mg/kg	2	NA	NA	NA	NA	NA	NA	NA	NA

SAMPID	TYPE	MATRIX	PREPDATE	ANADATE	BATCH	ANALYTE	RESULT	DL	RL	UNITS	DIL	SORC ID	SORC RES	SPIKE LVL	REC	RPD	U CL	L CL	RPDCL
B205048-BLK1	Blank	Soil/Sed	05/17/2012 14:08:00	05/17/2012 16:00:00	B205048	Antimony	ND	2.00	4.00	mg/kg	2	NA	NA	NA	NA	NA	NA	NA	NA
B205048-BLK1	Blank	Soil/Sed	05/17/2012 14:08:00	05/17/2012 16:00:00	B205048	Silver	ND	2.00	4.00	mg/kg	2	NA	NA	NA	NA	NA	NA	NA	NA
B205048-BLK1	Blank	Soil/Sed	05/17/2012 14:08:00	05/17/2012 16:00:00	B205048	Sodium	ND	2.00	4.00	mg/kg	2	NA	NA	NA	NA	NA	NA	NA	NA
B205048-BLK1	Blank	Soil/Sed	05/17/2012 14:08:00	05/17/2012 16:00:00	B205048	Thallium	ND	2.00	4.00	mg/kg	2	NA	NA	NA	NA	NA	NA	NA	NA
B205048-BLK1	Blank	Soil/Sed	05/17/2012 14:08:00	05/17/2012 16:00:00	B205048	Vanadium	ND	2.00	4.00	mg/kg	2	NA	NA	NA	NA	NA	NA	NA	NA
B205048-BLK1	Blank	Soil/Sed	05/17/2012 14:08:00	05/17/2012 16:00:00	B205048	Zinc	ND	2.00	4.00	mg/kg	2	NA	NA	NA	NA	NA	NA	NA	NA
B205048-BLK1	Blank	Soil/Sed	05/17/2012 14:08:00	05/17/2012 16:00:00	B205048	Arsenic	ND	2.00	4.00	mg/kg	2	NA	NA	NA	NA	NA	NA	NA	NA
B205048-BLK1	Blank	Soil/Sed	05/17/2012 14:08:00	05/17/2012 16:00:00	B205048	Barium	ND	2.00	4.00	mg/kg	2	NA	NA	NA	NA	NA	NA	NA	NA
B205048-BLK1	Blank	Soil/Sed	05/17/2012 14:08:00	05/17/2012 16:00:00	B205048	Beryllium	ND	2.00	4.00	mg/kg	2	NA	NA	NA	NA	NA	NA	NA	NA
B205048-BLK1	Blank	Soil/Sed	05/17/2012 14:08:00	05/17/2012 16:00:00	B205048	Cadmium	ND	2.00	4.00	mg/kg	2	NA	NA	NA	NA	NA	NA	NA	NA
B205048-BLK1	Blank	Soil/Sed	05/17/2012 14:08:00	05/17/2012 16:00:00	B205048	Calcium	ND	2.00	4.00	mg/kg	2	NA	NA	NA	NA	NA	NA	NA	NA
B205048-BLK1	Blank	Soil/Sed	05/17/2012 14:08:00	05/17/2012 16:00:00	B205048	Chromium	ND	2.00	4.00	mg/kg	2	NA	NA	NA	NA	NA	NA	NA	NA
B205048-BLK1	Blank	Soil/Sed	05/17/2012 14:08:00	05/17/2012 16:00:00	B205048	Cobalt	ND	2.00	4.00	mg/kg	2	NA	NA	NA	NA	NA	NA	NA	NA
B205048-BS1	LCS	Soil/Sed	05/17/2012 14:08:00	05/17/2012 16:00:00	B205048	Aluminum	250	2.00	4.00	mg/kg	2	NA	NA	250.0	100	NA	120	80	NA
B205048-BS1	LCS	Soil/Sed	05/17/2012 14:08:00	05/17/2012 16:00:00	B205048	Copper	252	2.00	4.00	mg/kg	2	NA	NA	250.0	101	NA	120	80	NA
B205048-BS1	LCS	Soil/Sed	05/17/2012 14:08:00	05/17/2012 16:00:00	B205048	Iron	264	2.00	4.00	mg/kg	2	NA	NA	250.0	105	NA	120	80	NA
B205048-BS1	LCS	Soil/Sed	05/17/2012 14:08:00	05/17/2012 16:00:00	B205048	Lead	251	2.00	4.00	mg/kg	2	NA	NA	250.0	100	NA	120	80	NA
B205048-BS1	LCS	Soil/Sed	05/17/2012 14:08:00	05/17/2012 16:00:00	B205048	Magnesium	256	2.00	4.00	mg/kg	2	NA	NA	250.0	102	NA	120	80	NA

SAMPID	TYPE	MATRIX	PREPDATE	ANADATE	BATCH	ANALYTE	RESULT	DL	RL	UNITS	DIL	SORC ID	SORC RES	SPIKE LVL	REC	RPD	U CL	L CL	RPDCL
B205048-BS1	LCS	Soil/Sed	05/17/2012 14:08:00	05/17/2012 16:00:00	B205048	Manganese	251	2.00	4.00	mg/kg	2	NA	NA	250.0	100	NA	120	80	NA
B205048-BS1	LCS	Soil/Sed	05/17/2012 14:08:00	05/17/2012 16:00:00	B205048	Nickel	253	2.00	4.00	mg/kg	2	NA	NA	250.0	101	NA	120	80	NA
B205048-BS1	LCS	Soil/Sed	05/17/2012 14:08:00	05/17/2012 16:00:00	B205048	Phosphorus	246	2.00	4.00	mg/kg	2	NA	NA	250.0	98.2	NA	120	80	NA
B205048-BS1	LCS	Soil/Sed	05/17/2012 14:08:00	05/17/2012 16:00:00	B205048	Potassium	242	2.00	4.00	mg/kg	2	NA	NA	250.0	96.6	NA	120	80	NA
B205048-BS1	LCS	Soil/Sed	05/17/2012 14:08:00	05/17/2012 16:00:00	B205048	Selenium	245	2.00	4.00	mg/kg	2	NA	NA	250.0	98.1	NA	120	80	NA
B205048-BS1	LCS	Soil/Sed	05/17/2012 14:08:00	05/17/2012 16:00:00	B205048	Antimony	242	2.00	4.00	mg/kg	2	NA	NA	250.0	97.0	NA	120	80	NA
B205048-BS1	LCS	Soil/Sed	05/17/2012 14:08:00	05/17/2012 16:00:00	B205048	Silver	245	2.00	4.00	mg/kg	2	NA	NA	250.0	98.0	NA	120	80	NA
B205048-BS1	LCS	Soil/Sed	05/17/2012 14:08:00	05/17/2012 16:00:00	B205048	Sodium	247	2.00	4.00	mg/kg	2	NA	NA	250.0	98.9	NA	120	80	NA
B205048-BS1	LCS	Soil/Sed	05/17/2012 14:08:00	05/17/2012 16:00:00	B205048	Thallium	254	2.00	4.00	mg/kg	2	NA	NA	250.0	101	NA	120	80	NA
B205048-BS1	LCS	Soil/Sed	05/17/2012 14:08:00	05/17/2012 16:00:00	B205048	Vanadium	243	2.00	4.00	mg/kg	2	NA	NA	250.0	97.3	NA	120	80	NA
B205048-BS1	LCS	Soil/Sed	05/17/2012 14:08:00	05/17/2012 16:00:00	B205048	Zinc	257	2.00	4.00	mg/kg	2	NA	NA	250.0	103	NA	120	80	NA
B205048-BS1	LCS	Soil/Sed	05/17/2012 14:08:00	05/17/2012 16:00:00	B205048	Arsenic	242	2.00	4.00	mg/kg	2	NA	NA	250.0	96.6	NA	120	80	NA
B205048-BS1	LCS	Soil/Sed	05/17/2012 14:08:00	05/17/2012 16:00:00	B205048	Barium	243	2.00	4.00	mg/kg	2	NA	NA	250.0	97.0	NA	120	80	NA
B205048-BS1	LCS	Soil/Sed	05/17/2012 14:08:00	05/17/2012 16:00:00	B205048	Beryllium	248	2.00	4.00	mg/kg	2	NA	NA	250.0	99.4	NA	120	80	NA
B205048-BS1	LCS	Soil/Sed	05/17/2012 14:08:00	05/17/2012 16:00:00	B205048	Cadmium	198	2.00	4.00	mg/kg	2	NA	NA	250.0	79.3	NA	120	80	NA
B205048-BS1	LCS	Soil/Sed	05/17/2012 14:08:00	05/17/2012 16:00:00	B205048	Calcium	253	2.00	4.00	mg/kg	2	NA	NA	250.0	101	NA	120	80	NA
B205048-BS1	LCS	Soil/Sed	05/17/2012 14:08:00	05/17/2012 16:00:00	B205048	Chromium	251	2.00	4.00	mg/kg	2	NA	NA	250.0	100	NA	120	80	NA
B205048-BS1	LCS	Soil/Sed	05/17/2012 14:08:00	05/17/2012 16:00:00	B205048	Cobalt	251	2.00	4.00	mg/kg	2	NA	NA	250.0	101	NA	120	80	NA

SAMPID	TYPE	MATRIX	PREPDATE	ANADATE	BATCH	ANALYTE	RESULT	DL	RL	UNITS	DIL	SORC ID	SORC RES	SPIKE LVL	REC	RPD	U CL	L CL	RPDCL
B207045-BLK1	Blank	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Aluminum	ND	0.0200	0.0400	mg/L	2	NA	NA	NA	NA	NA	NA	NA	NA
B207045-BLK1	Blank	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Cobalt	ND	0.0200	0.0400	mg/L	2	NA	NA	NA	NA	NA	NA	NA	NA
B207045-BLK1	Blank	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Copper	ND	0.0200	0.0400	mg/L	2	NA	NA	NA	NA	NA	NA	NA	NA
B207045-BLK1	Blank	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Iron	ND	0.0200	0.0400	mg/L	2	NA	NA	NA	NA	NA	NA	NA	NA
B207045-BLK1	Blank	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Lead	ND	0.0200	0.0400	mg/L	2	NA	NA	NA	NA	NA	NA	NA	NA
B207045-BLK1	Blank	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Magnesium	ND	0.0200	0.0400	mg/L	2	NA	NA	NA	NA	NA	NA	NA	NA
B207045-BLK1	Blank	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Manganese	ND	0.0200	0.0400	mg/L	2	NA	NA	NA	NA	NA	NA	NA	NA
B207045-BLK1	Blank	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Nickel	ND	0.0200	0.0400	mg/L	2	NA	NA	NA	NA	NA	NA	NA	NA
B207045-BLK1	Blank	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Phosphorus	ND	0.0200	0.0400	mg/L	2	NA	NA	NA	NA	NA	NA	NA	NA
B207045-BLK1	Blank	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Potassium	ND	0.0200	0.0400	mg/L	2	NA	NA	NA	NA	NA	NA	NA	NA
B207045-BLK1	Blank	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Antimony	ND	0.0200	0.0400	mg/L	2	NA	NA	NA	NA	NA	NA	NA	NA
B207045-BLK1	Blank	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Selenium	ND	0.0200	0.0400	mg/L	2	NA	NA	NA	NA	NA	NA	NA	NA
B207045-BLK1	Blank	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Silver	ND	0.0200	0.0400	mg/L	2	NA	NA	NA	NA	NA	NA	NA	NA
B207045-BLK1	Blank	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Sodium	ND	0.0200	0.0400	mg/L	2	NA	NA	NA	NA	NA	NA	NA	NA
B207045-BLK1	Blank	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Thallium	ND	0.0200	0.0400	mg/L	2	NA	NA	NA	NA	NA	NA	NA	NA
B207045-BLK1	Blank	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Arsenic	ND	0.0200	0.0400	mg/L	2	NA	NA	NA	NA	NA	NA	NA	NA
B207045-BLK1	Blank	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Vanadium	ND	0.0200	0.0400	mg/L	2	NA	NA	NA	NA	NA	NA	NA	NA
B207045-BLK1	Blank	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Zinc	ND	0.0200	0.0400	mg/L	2	NA	NA	NA	NA	NA	NA	NA	NA

SAMPID	TYPE	MATRIX	PREPDATE	ANADATE	BATCH	ANALYTE	RESULT	DL	RL	UNITS	DIL	SORC ID	SORC RES	SPIKE LVL	REC	RPD	U CL	L CL	RPDCL
B207045-BLK1	Blank	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Barium	ND	0.0200	0.0400	mg/L	2	NA	NA	NA	NA	NA	NA	NA	NA
B207045-BLK1	Blank	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Beryllium	ND	0.0200	0.0400	mg/L	2	NA	NA	NA	NA	NA	NA	NA	NA
B207045-BLK1	Blank	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Cadmium	ND	0.0200	0.0400	mg/L	2	NA	NA	NA	NA	NA	NA	NA	NA
B207045-BLK1	Blank	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Calcium	ND	0.0200	0.0400	mg/L	2	NA	NA	NA	NA	NA	NA	NA	NA
B207045-BLK1	Blank	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Chromium	ND	0.0200	0.0400	mg/L	2	NA	NA	NA	NA	NA	NA	NA	NA
B207045-BS1	LCS	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Aluminum	2.45	0.0200	0.0400	mg/L	2	NA	NA	2.500	98.1	NA	120	80	NA
B207045-BS1	LCS	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Cobalt	2.50	0.0200	0.0400	mg/L	2	NA	NA	2.500	100	NA	120	80	NA
B207045-BS1	LCS	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Copper	2.52	0.0200	0.0400	mg/L	2	NA	NA	2.500	101	NA	120	80	NA
B207045-BS1	LCS	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Iron	2.58	0.0200	0.0400	mg/L	2	NA	NA	2.500	103	NA	120	80	NA
B207045-BS1	LCS	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Lead	2.52	0.0200	0.0400	mg/L	2	NA	NA	2.500	101	NA	120	80	NA
B207045-BS1	LCS	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Magnesium	2.51	0.0200	0.0400	mg/L	2	NA	NA	2.500	101	NA	120	80	NA
B207045-BS1	LCS	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Manganese	2.49	0.0200	0.0400	mg/L	2	NA	NA	2.500	99.6	NA	120	80	NA
B207045-BS1	LCS	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Nickel	2.55	0.0200	0.0400	mg/L	2	NA	NA	2.500	102	NA	120	80	NA
B207045-BS1	LCS	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Phosphorus	2.41	0.0200	0.0400	mg/L	2	NA	NA	2.500	96.6	NA	120	80	NA
B207045-BS1	LCS	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Potassium	2.37	0.0200	0.0400	mg/L	2	NA	NA	2.500	94.7	NA	120	80	NA
B207045-BS1	LCS	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Antimony	2.43	0.0200	0.0400	mg/L	2	NA	NA	2.500	97.1	NA	120	80	NA
B207045-BS1	LCS	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Selenium	2.43	0.0200	0.0400	mg/L	2	NA	NA	2.500	97.4	NA	120	80	NA
B207045-BS1	LCS	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Silver	2.44	0.0200	0.0400	mg/L	2	NA	NA	2.500	97.8	NA	120	80	NA

SAMPID	TYPE	MATRIX	PREPDATE	ANADATE	BATCH	ANALYTE	RESULT	DL	RL	UNITS	DIL	SORC ID	SORC RES	SPIKE LVL	REC	RPD	U CL	L CL	RPDCL
B207045-BS1	LCS	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Sodium	2.45	0.0200	0.0400	mg/L	2	NA	NA	2.500	97.8	NA	120	80	NA
B207045-BS1	LCS	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Thallium	2.53	0.0200	0.0400	mg/L	2	NA	NA	2.500	101	NA	120	80	NA
B207045-BS1	LCS	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Arsenic	2.43	0.0200	0.0400	mg/L	2	NA	NA	2.500	97.0	NA	120	80	NA
B207045-BS1	LCS	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Vanadium	2.43	0.0200	0.0400	mg/L	2	NA	NA	2.500	97.2	NA	120	80	NA
B207045-BS1	LCS	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Zinc	2.58	0.0200	0.0400	mg/L	2	NA	NA	2.500	103	NA	120	80	NA
B207045-BS1	LCS	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Barium	2.45	0.0200	0.0400	mg/L	2	NA	NA	2.500	97.9	NA	120	80	NA
B207045-BS1	LCS	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Beryllium	2.46	0.0200	0.0400	mg/L	2	NA	NA	2.500	98.3	NA	120	80	NA
B207045-BS1	LCS	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Cadmium	1.95	0.0200	0.0400	mg/L	2	NA	NA	2.500	77.8	NA	120	80	NA
B207045-BS1	LCS	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Calcium	2.52	0.0200	0.0400	mg/L	2	NA	NA	2.500	101	NA	120	80	NA
B207045-BS1	LCS	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Chromium	2.53	0.0200	0.0400	mg/L	2	NA	NA	2.500	101	NA	120	80	NA
B207045-DUP1	Dup	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Aluminum	0.0562	0.0200	0.0400	mg/L	2	20510 01-01	0.0552	NA	NA	1.79	NA	NA	20
B207045-DUP1	Dup	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Cobalt	ND	0.0200	0.0400	mg/L	2	20510 01-01	ND	NA	NA		NA	NA	20
B207045-DUP1	Dup	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Copper	0.0401	0.0200	0.0400	mg/L	2	20510 01-01	0.0488	NA	NA	19.8	NA	NA	20
B207045-DUP1	Dup	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Iron	0.333	0.0200	0.0400	mg/L	2	20510 01-01	0.333	NA	NA	0.0736	NA	NA	20
B207045-DUP1	Dup	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Lead	ND	0.0200	0.0400	mg/L	2	20510 01-01	0.0240	NA	NA		NA	NA	20
B207045-DUP1	Dup	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Magnesium	0.163	0.0200	0.0400	mg/L	2	20510 01-01	0.147	NA	NA	10.1	NA	NA	20
B207045-DUP1	Dup	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Manganese	0.0238	0.0200	0.0400	mg/L	2	20510 01-01	0.0241	NA	NA	1.31	NA	NA	20
B207045-DUP1	Dup	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Nickel	0.106	0.0200	0.0400	mg/L	2	20510 01-01	0.109	NA	NA	2.85	NA	NA	20

SAMPID	TYPE	MATRIX	PREPDATE	ANADATE	BATCH	ANALYTE	RESULT	DL	RL	UNITS	DIL	SORC ID	SORC RES	SPIKE LVL	REC	RPD	U CL	L CL	RPDCL
B207045-DUP1	Dup	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Phosphorus	ND	0.0200	0.0400	mg/L	2	2051001-01	ND	NA	NA		NA	NA	20
B207045-DUP1	Dup	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Potassium	0.289	0.0200	0.0400	mg/L	2	2051001-01	0.390	NA	NA	29.7	NA	NA	20
B207045-DUP1	Dup	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Antimony	ND	0.0200	0.0400	mg/L	2	2051001-01	0.0285	NA	NA		NA	NA	20
B207045-DUP1	Dup	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Selenium	ND	0.0200	0.0400	mg/L	2	2051001-01	ND	NA	NA		NA	NA	20
B207045-DUP1	Dup	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Silver	ND	0.0200	0.0400	mg/L	2	2051001-01	0.0220	NA	NA		NA	NA	20
B207045-DUP1	Dup	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Sodium	0.141	0.0200	0.0400	mg/L	2	2051001-01	0.177	NA	NA	22.5	NA	NA	20
B207045-DUP1	Dup	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Thallium	ND	0.0200	0.0400	mg/L	2	2051001-01	ND	NA	NA		NA	NA	20
B207045-DUP1	Dup	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Arsenic	ND	0.0200	0.0400	mg/L	2	2051001-01	ND	NA	NA		NA	NA	20
B207045-DUP1	Dup	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Vanadium	ND	0.0200	0.0400	mg/L	2	2051001-01	ND	NA	NA		NA	NA	20
B207045-DUP1	Dup	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Zinc	0.0442	0.0200	0.0400	mg/L	2	2051001-01	0.0757	NA	NA	52.5	NA	NA	20
B207045-DUP1	Dup	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Barium	ND	0.0200	0.0400	mg/L	2	2051001-01	ND	NA	NA		NA	NA	20
B207045-DUP1	Dup	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Beryllium	ND	0.0200	0.0400	mg/L	2	2051001-01	ND	NA	NA		NA	NA	20
B207045-DUP1	Dup	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Cadmium	ND	0.0200	0.0400	mg/L	2	2051001-01	0.0315	NA	NA		NA	NA	20
B207045-DUP1	Dup	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Calcium	0.265	0.0200	0.0400	mg/L	2	2051001-01	0.278	NA	NA	4.78	NA	NA	20
B207045-DUP1	Dup	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Chromium	0.0896	0.0200	0.0400	mg/L	2	2051001-01	0.0927	NA	NA	3.49	NA	NA	20
B207045-DUP2	Dup	Water	05/22/2012 00:00:00	05/25/2012 16:10:00	B207045	Aluminum	0.0535	0.0200	0.0400	mg/L	2	2052501-01	0.0354	NA	NA	40.7	NA	NA	20
B207045-DUP2	Dup	Water	05/22/2012 00:00:00	05/25/2012 16:10:00	B207045	Cobalt	ND	0.0200	0.0400	mg/L	2	2052501-01	ND	NA	NA		NA	NA	20
B207045-DUP2	Dup	Water	05/22/2012 00:00:00	05/25/2012 16:10:00	B207045	Copper	0.0451	0.0200	0.0400	mg/L	2	2052501-01	0.0653	NA	NA	36.7	NA	NA	20

SAMPID	TYPE	MATRIX	PREPDATE	ANADATE	BATCH	ANALYTE	RESULT	DL	RL	UNITS	DIL	SORC ID	SORC RES	SPIKE LVL	REC	RPD	U CL	L CL	RPDCL
B207045-DUP2	Dup	Water	05/22/2012 00:00:00	05/25/2012 16:10:00	B207045	Iron	0.0995	0.0200	0.0400	mg/L	2	20525 01-01	0.0801	NA	NA	21.6	NA	NA	20
B207045-DUP2	Dup	Water	05/22/2012 00:00:00	05/25/2012 16:10:00	B207045	Lead	0.0710	0.0200	0.0400	mg/L	2	20525 01-01	0.196	NA	NA	93.8	NA	NA	20
B207045-DUP2	Dup	Water	05/22/2012 00:00:00	05/25/2012 16:10:00	B207045	Magnesium	0.192	0.0200	0.0400	mg/L	2	20525 01-01	0.135	NA	NA	34.6	NA	NA	20
B207045-DUP2	Dup	Water	05/22/2012 00:00:00	05/25/2012 16:10:00	B207045	Manganese	ND	0.0200	0.0400	mg/L	2	20525 01-01	ND	NA	NA		NA	NA	20
B207045-DUP2	Dup	Water	05/22/2012 00:00:00	05/25/2012 16:10:00	B207045	Nickel	ND	0.0200	0.0400	mg/L	2	20525 01-01	ND	NA	NA		NA	NA	20
B207045-DUP2	Dup	Water	05/22/2012 00:00:00	05/25/2012 16:10:00	B207045	Phosphorus	0.0495	0.0200	0.0400	mg/L	2	20525 01-01	0.0708	NA	NA	35.5	NA	NA	20
B207045-DUP2	Dup	Water	05/22/2012 00:00:00	05/25/2012 16:10:00	B207045	Potassium	0.516	0.0200	0.0400	mg/L	2	20525 01-01	0.488	NA	NA	5.57	NA	NA	20
B207045-DUP2	Dup	Water	05/22/2012 00:00:00	05/25/2012 16:10:00	B207045	Antimony	0.0687	0.0200	0.0400	mg/L	2	20525 01-01	0.152	NA	NA	75.5	NA	NA	20
B207045-DUP2	Dup	Water	05/22/2012 00:00:00	05/25/2012 16:10:00	B207045	Selenium	ND	0.0200	0.0400	mg/L	2	20525 01-01	ND	NA	NA		NA	NA	20
B207045-DUP2	Dup	Water	05/22/2012 00:00:00	05/25/2012 16:10:00	B207045	Silver	ND	0.0200	0.0400	mg/L	2	20525 01-01	0.0208	NA	NA		NA	NA	20
B207045-DUP2	Dup	Water	05/22/2012 00:00:00	05/25/2012 16:10:00	B207045	Sodium	0.478	0.0200	0.0400	mg/L	2	20525 01-01	0.455	NA	NA	4.91	NA	NA	20
B207045-DUP2	Dup	Water	05/22/2012 00:00:00	05/25/2012 16:10:00	B207045	Thallium	ND	0.0200	0.0400	mg/L	2	20525 01-01	ND	NA	NA		NA	NA	20
B207045-DUP2	Dup	Water	05/22/2012 00:00:00	05/25/2012 16:10:00	B207045	Arsenic	ND	0.0200	0.0400	mg/L	2	20525 01-01	ND	NA	NA		NA	NA	20
B207045-DUP2	Dup	Water	05/22/2012 00:00:00	05/25/2012 16:10:00	B207045	Vanadium	ND	0.0200	0.0400	mg/L	2	20525 01-01	ND	NA	NA		NA	NA	20
B207045-DUP2	Dup	Water	05/22/2012 00:00:00	05/25/2012 16:10:00	B207045	Zinc	0.0589	0.0200	0.0400	mg/L	2	20525 01-01	0.0922	NA	NA	44.1	NA	NA	20
B207045-DUP2	Dup	Water	05/22/2012 00:00:00	05/25/2012 16:10:00	B207045	Barium	ND	0.0200	0.0400	mg/L	2	20525 01-01	ND	NA	NA		NA	NA	20
B207045-DUP2	Dup	Water	05/22/2012 00:00:00	05/25/2012 16:10:00	B207045	Beryllium	ND	0.0200	0.0400	mg/L	2	20525 01-01	ND	NA	NA		NA	NA	20
B207045-DUP2	Dup	Water	05/22/2012 00:00:00	05/25/2012 16:10:00	B207045	Cadmium	ND	0.0200	0.0400	mg/L	2	20525 01-01	ND	NA	NA		NA	NA	20

SAMPID	TYPE	MATRIX	PREPDATE	ANADATE	BATCH	ANALYTE	RESULT	DL	RL	UNITS	DIL	SORC ID	SORC RES	SPIKE LVL	REC	RPD	U CL	L CL	RPDCL
B207045-DUP2	Dup	Water	05/22/2012 00:00:00	05/25/2012 16:10:00	B207045	Calcium	0.275	0.0200	0.0400	mg/L	2	2052501-01	0.248	NA	NA	10.4	NA	NA	20
B207045-DUP2	Dup	Water	05/22/2012 00:00:00	05/25/2012 16:10:00	B207045	Chromium	ND	0.0200	0.0400	mg/L	2	2052501-01	ND	NA	NA		NA	NA	20
B207045-MS1	Matrix Spike	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Aluminum	1.98	0.0200	0.0400	mg/L	2	2051001-01	0.0552	2.000	96.4	NA	120	80	NA
B207045-MS1	Matrix Spike	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Cobalt	2.00	0.0200	0.0400	mg/L	2	2051001-01	ND	2.000	99.9	NA	120	80	NA
B207045-MS1	Matrix Spike	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Copper	2.05	0.0200	0.0400	mg/L	2	2051001-01	0.0488	2.000	100	NA	120	80	NA
B207045-MS1	Matrix Spike	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Iron	2.40	0.0200	0.0400	mg/L	2	2051001-01	0.333	2.000	103	NA	120	80	NA
B207045-MS1	Matrix Spike	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Lead	1.97	0.0200	0.0400	mg/L	2	2051001-01	0.0240	2.000	97.1	NA	120	80	NA
B207045-MS1	Matrix Spike	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Magnesium	2.12	0.0200	0.0400	mg/L	2	2051001-01	0.147	2.000	98.8	NA	120	80	NA
B207045-MS1	Matrix Spike	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Manganese	2.06	0.0200	0.0400	mg/L	2	2051001-01	0.0241	2.000	102	NA	120	80	NA
B207045-MS1	Matrix Spike	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Nickel	2.12	0.0200	0.0400	mg/L	2	2051001-01	0.109	2.000	100	NA	120	80	NA
B207045-MS1	Matrix Spike	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Phosphorus	1.84	0.0200	0.0400	mg/L	2	2051001-01	ND	2.000	91.8	NA	120	80	NA
B207045-MS1	Matrix Spike	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Potassium	2.10	0.0200	0.0400	mg/L	2	2051001-01	0.390	2.000	85.7	NA	120	80	NA
B207045-MS1	Matrix Spike	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Antimony	1.85	0.0200	0.0400	mg/L	2	2051001-01	0.0285	2.000	91.2	NA	120	80	NA
B207045-MS1	Matrix Spike	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Selenium	1.82	0.0200	0.0400	mg/L	2	2051001-01	ND	2.000	91.2	NA	120	80	NA
B207045-MS1	Matrix Spike	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Silver	1.88	0.0200	0.0400	mg/L	2	2051001-01	0.0220	2.000	93.0	NA	120	80	NA
B207045-MS1	Matrix Spike	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Sodium	2.05	0.0200	0.0400	mg/L	2	2051001-01	0.177	2.000	93.7	NA	120	80	NA
B207045-MS1	Matrix Spike	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Thallium	1.96	0.0200	0.0400	mg/L	2	2051001-01	ND	2.000	98.2	NA	120	80	NA
B207045-MS1	Matrix Spike	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Arsenic	1.88	0.0200	0.0400	mg/L	2	2051001-01	ND	2.000	94.2	NA	120	80	NA

SAMPID	TYPE	MATRIX	PREPDATE	ANADATE	BATCH	ANALYTE	RESULT	DL	RL	UNITS	DIL	SORC ID	SORC RES	SPIKE LVL	REC	RPD	U CL	L CL	RPDCL
B207045-MS1	Matrix Spike	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Vanadium	1.95	0.0200	0.0400	mg/L	2	2051001-01	ND	2.000	97.3	NA	120	80	NA
B207045-MS1	Matrix Spike	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Zinc	1.95	0.0200	0.0400	mg/L	2	2051001-01	0.0757	2.000	93.6	NA	120	80	NA
B207045-MS1	Matrix Spike	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Barium	1.93	0.0200	0.0400	mg/L	2	2051001-01	ND	2.000	96.6	NA	120	80	NA
B207045-MS1	Matrix Spike	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Beryllium	1.95	0.0200	0.0400	mg/L	2	2051001-01	ND	2.000	97.6	NA	120	80	NA
B207045-MS1	Matrix Spike	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Cadmium	1.96	0.0200	0.0400	mg/L	2	2051001-01	0.0315	2.000	96.4	NA	120	80	NA
B207045-MS1	Matrix Spike	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Calcium	2.28	0.0200	0.0400	mg/L	2	2051001-01	0.278	2.000	99.9	NA	120	80	NA
B207045-MS1	Matrix Spike	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Chromium	2.13	0.0200	0.0400	mg/L	2	2051001-01	0.0927	2.000	102	NA	120	80	NA
B207045-MS2	Matrix Spike	Water	05/22/2012 00:00:00	05/25/2012 16:10:00	B207045	Aluminum	2.09	0.0200	0.0400	mg/L	2	2052501-01	0.0354	2.000	103	NA	120	80	NA
B207045-MS2	Matrix Spike	Water	05/22/2012 00:00:00	05/25/2012 16:10:00	B207045	Cobalt	2.06	0.0200	0.0400	mg/L	2	2052501-01	ND	2.000	103	NA	120	80	NA
B207045-MS2	Matrix Spike	Water	05/22/2012 00:00:00	05/25/2012 16:10:00	B207045	Copper	2.15	0.0200	0.0400	mg/L	2	2052501-01	0.0653	2.000	104	NA	120	80	NA
B207045-MS2	Matrix Spike	Water	05/22/2012 00:00:00	05/25/2012 16:10:00	B207045	Iron	2.23	0.0200	0.0400	mg/L	2	2052501-01	0.0801	2.000	108	NA	120	80	NA
B207045-MS2	Matrix Spike	Water	05/22/2012 00:00:00	05/25/2012 16:10:00	B207045	Lead	2.06	0.0200	0.0400	mg/L	2	2052501-01	0.196	2.000	93.2	NA	120	80	NA
B207045-MS2	Matrix Spike	Water	05/22/2012 00:00:00	05/25/2012 16:10:00	B207045	Magnesium	2.25	0.0200	0.0400	mg/L	2	2052501-01	0.135	2.000	106	NA	120	80	NA
B207045-MS2	Matrix Spike	Water	05/22/2012 00:00:00	05/25/2012 16:10:00	B207045	Manganese	2.06	0.0200	0.0400	mg/L	2	2052501-01	ND	2.000	103	NA	120	80	NA
B207045-MS2	Matrix Spike	Water	05/22/2012 00:00:00	05/25/2012 16:10:00	B207045	Nickel	2.07	0.0200	0.0400	mg/L	2	2052501-01	ND	2.000	103	NA	120	80	NA
B207045-MS2	Matrix Spike	Water	05/22/2012 00:00:00	05/25/2012 16:10:00	B207045	Phosphorus	1.94	0.0200	0.0400	mg/L	2	2052501-01	0.0708	2.000	93.2	NA	120	80	NA
B207045-MS2	Matrix Spike	Water	05/22/2012 00:00:00	05/25/2012 16:10:00	B207045	Potassium	2.43	0.0200	0.0400	mg/L	2	2052501-01	0.488	2.000	96.9	NA	120	80	NA
B207045-MS2	Matrix Spike	Water	05/22/2012 00:00:00	05/25/2012 16:10:00	B207045	Antimony	1.97	0.0200	0.0400	mg/L	2	2052501-01	0.152	2.000	90.8	NA	120	80	NA

SAMPID	TYPE	MATRIX	PREPDATE	ANADATE	BATCH	ANALYTE	RESULT	DL	RL	UNITS	DIL	SORC ID	SORC RES	SPIKE LVL	REC	RPD	U CL	L CL	RPDCL
B207045-MS2	Matrix Spike	Water	05/22/2012 00:00:00	05/25/2012 16:10:00	B207045	Selenium	1.92	0.0200	0.0400	mg/L	2	20525 01-01	ND	2.000	96.1	NA	120	80	NA
B207045-MS2	Matrix Spike	Water	05/22/2012 00:00:00	05/25/2012 16:10:00	B207045	Silver	1.97	0.0200	0.0400	mg/L	2	20525 01-01	0.0208	2.000	97.6	NA	120	80	NA
B207045-MS2	Matrix Spike	Water	05/22/2012 00:00:00	05/25/2012 16:10:00	B207045	Sodium	2.48	0.0200	0.0400	mg/L	2	20525 01-01	0.455	2.000	101	NA	120	80	NA
B207045-MS2	Matrix Spike	Water	05/22/2012 00:00:00	05/25/2012 16:10:00	B207045	Thallium	2.05	0.0200	0.0400	mg/L	2	20525 01-01	ND	2.000	102	NA	120	80	NA
B207045-MS2	Matrix Spike	Water	05/22/2012 00:00:00	05/25/2012 16:10:00	B207045	Arsenic	1.94	0.0200	0.0400	mg/L	2	20525 01-01	ND	2.000	97.2	NA	120	80	NA
B207045-MS2	Matrix Spike	Water	05/22/2012 00:00:00	05/25/2012 16:10:00	B207045	Vanadium	2.01	0.0200	0.0400	mg/L	2	20525 01-01	ND	2.000	100	NA	120	80	NA
B207045-MS2	Matrix Spike	Water	05/22/2012 00:00:00	05/25/2012 16:10:00	B207045	Zinc	2.02	0.0200	0.0400	mg/L	2	20525 01-01	0.0922	2.000	96.4	NA	120	80	NA
B207045-MS2	Matrix Spike	Water	05/22/2012 00:00:00	05/25/2012 16:10:00	B207045	Barium	2.03	0.0200	0.0400	mg/L	2	20525 01-01	ND	2.000	101	NA	120	80	NA
B207045-MS2	Matrix Spike	Water	05/22/2012 00:00:00	05/25/2012 16:10:00	B207045	Beryllium	2.07	0.0200	0.0400	mg/L	2	20525 01-01	ND	2.000	104	NA	120	80	NA
B207045-MS2	Matrix Spike	Water	05/22/2012 00:00:00	05/25/2012 16:10:00	B207045	Cadmium	2.03	0.0200	0.0400	mg/L	2	20525 01-01	ND	2.000	102	NA	120	80	NA
B207045-MS2	Matrix Spike	Water	05/22/2012 00:00:00	05/25/2012 16:10:00	B207045	Calcium	2.34	0.0200	0.0400	mg/L	2	20525 01-01	0.248	2.000	104	NA	120	80	NA
B207045-MS2	Matrix Spike	Water	05/22/2012 00:00:00	05/25/2012 16:10:00	B207045	Chromium	2.10	0.0200	0.0400	mg/L	2	20525 01-01	ND	2.000	105	NA	120	80	NA
B205058-BLK1	Blank	Soil/Sed	05/21/2012 08:16:00	05/21/2012 19:33:00	B205058	Aluminum	ND	1.00	2.00	mg/kg	1	NA	NA	NA	NA	NA	NA	NA	NA
B205058-BLK1	Blank	Soil/Sed	05/21/2012 08:16:00	05/21/2012 19:33:00	B205058	Copper	ND	1.00	2.00	mg/kg	1	NA	NA	NA	NA	NA	NA	NA	NA
B205058-BLK1	Blank	Soil/Sed	05/21/2012 08:16:00	05/21/2012 19:33:00	B205058	Iron	ND	1.00	2.00	mg/kg	1	NA	NA	NA	NA	NA	NA	NA	NA
B205058-BLK1	Blank	Soil/Sed	05/21/2012 08:16:00	05/21/2012 19:33:00	B205058	Lead	ND	1.00	2.00	mg/kg	1	NA	NA	NA	NA	NA	NA	NA	NA
B205058-BLK1	Blank	Soil/Sed	05/21/2012 08:16:00	05/21/2012 19:33:00	B205058	Magnesium	ND	1.00	2.00	mg/kg	1	NA	NA	NA	NA	NA	NA	NA	NA
B205058-BLK1	Blank	Soil/Sed	05/21/2012 08:16:00	05/21/2012 19:33:00	B205058	Manganese	ND	1.00	2.00	mg/kg	1	NA	NA	NA	NA	NA	NA	NA	NA

SAMPID	TYPE	MATRIX	PREPDATE	ANADATE	BATCH	ANALYTE	RESULT	DL	RL	UNITS	DIL	SORC ID	SORC RES	SPIKE LVL	REC	RPD	U CL	L CL	RPDCL
B205058-BLK1	Blank	Soil/Sed	05/21/2012 08:16:00	05/21/2012 19:33:00	B205058	Nickel	ND	1.00	2.00	mg/kg	1	NA	NA	NA	NA	NA	NA	NA	NA
B205058-BLK1	Blank	Soil/Sed	05/21/2012 08:16:00	05/21/2012 19:33:00	B205058	Phosphorus	ND	1.00	2.00	mg/kg	1	NA	NA	NA	NA	NA	NA	NA	NA
B205058-BLK1	Blank	Soil/Sed	05/21/2012 08:16:00	05/21/2012 19:33:00	B205058	Potassium	ND	1.00	2.00	mg/kg	1	NA	NA	NA	NA	NA	NA	NA	NA
B205058-BLK1	Blank	Soil/Sed	05/21/2012 08:16:00	05/21/2012 19:33:00	B205058	Selenium	ND	1.00	2.00	mg/kg	1	NA	NA	NA	NA	NA	NA	NA	NA
B205058-BLK1	Blank	Soil/Sed	05/21/2012 08:16:00	05/21/2012 19:33:00	B205058	Antimony	ND	1.00	2.00	mg/kg	1	NA	NA	NA	NA	NA	NA	NA	NA
B205058-BLK1	Blank	Soil/Sed	05/21/2012 08:16:00	05/21/2012 19:33:00	B205058	Silver	ND	1.00	2.00	mg/kg	1	NA	NA	NA	NA	NA	NA	NA	NA
B205058-BLK1	Blank	Soil/Sed	05/21/2012 08:16:00	05/21/2012 19:33:00	B205058	Sodium	1.72	1.00	2.00	mg/kg	1	NA	NA	NA	NA	NA	NA	NA	NA
B205058-BLK1	Blank	Soil/Sed	05/21/2012 08:16:00	05/21/2012 19:33:00	B205058	Thallium	ND	1.00	2.00	mg/kg	1	NA	NA	NA	NA	NA	NA	NA	NA
B205058-BLK1	Blank	Soil/Sed	05/21/2012 08:16:00	05/21/2012 19:33:00	B205058	Vanadium	ND	1.00	2.00	mg/kg	1	NA	NA	NA	NA	NA	NA	NA	NA
B205058-BLK1	Blank	Soil/Sed	05/21/2012 08:16:00	05/21/2012 19:33:00	B205058	Zinc	ND	1.00	2.00	mg/kg	1	NA	NA	NA	NA	NA	NA	NA	NA
B205058-BLK1	Blank	Soil/Sed	05/21/2012 08:16:00	05/21/2012 19:33:00	B205058	Arsenic	ND	1.00	2.00	mg/kg	1	NA	NA	NA	NA	NA	NA	NA	NA
B205058-BLK1	Blank	Soil/Sed	05/21/2012 08:16:00	05/21/2012 19:33:00	B205058	Barium	ND	1.00	2.00	mg/kg	1	NA	NA	NA	NA	NA	NA	NA	NA
B205058-BLK1	Blank	Soil/Sed	05/21/2012 08:16:00	05/21/2012 19:33:00	B205058	Beryllium	ND	1.00	2.00	mg/kg	1	NA	NA	NA	NA	NA	NA	NA	NA
B205058-BLK1	Blank	Soil/Sed	05/21/2012 08:16:00	05/21/2012 19:33:00	B205058	Cadmium	ND	1.00	2.00	mg/kg	1	NA	NA	NA	NA	NA	NA	NA	NA
B205058-BLK1	Blank	Soil/Sed	05/21/2012 08:16:00	05/21/2012 19:33:00	B205058	Calcium	ND	1.00	2.00	mg/kg	1	NA	NA	NA	NA	NA	NA	NA	NA
B205058-BLK1	Blank	Soil/Sed	05/21/2012 08:16:00	05/21/2012 19:33:00	B205058	Chromium	ND	1.00	2.00	mg/kg	1	NA	NA	NA	NA	NA	NA	NA	NA
B205058-BLK1	Blank	Soil/Sed	05/21/2012 08:16:00	05/21/2012 19:33:00	B205058	Cobalt	ND	1.00	2.00	mg/kg	1	NA	NA	NA	NA	NA	NA	NA	NA
B205058-BS1	LCS	Soil/Sed	05/21/2012 08:16:00	05/21/2012 19:33:00	B205058	Aluminum	248	1.00	2.00	mg/kg	1	NA	NA	250.0	99.1	NA	120	80	NA

SAMPID	TYPE	MATRIX	PREPDATE	ANADATE	BATCH	ANALYTE	RESULT	DL	RL	UNITS	DIL	SORC ID	SORC RES	SPIKE LVL	REC	RPD	U CL	L CL	RPDCL
B205058-BS1	LCS	Soil/Sed	05/21/2012 08:16:00	05/21/2012 19:33:00	B205058	Copper	252	1.00	2.00	mg/kg	1	NA	NA	250.0	101	NA	120	80	NA
B205058-BS1	LCS	Soil/Sed	05/21/2012 08:16:00	05/21/2012 19:33:00	B205058	Iron	261	1.00	2.00	mg/kg	1	NA	NA	250.0	105	NA	120	80	NA
B205058-BS1	LCS	Soil/Sed	05/21/2012 08:16:00	05/21/2012 19:33:00	B205058	Lead	253	1.00	2.00	mg/kg	1	NA	NA	250.0	101	NA	120	80	NA
B205058-BS1	LCS	Soil/Sed	05/21/2012 08:16:00	05/21/2012 19:33:00	B205058	Magnesium	254	1.00	2.00	mg/kg	1	NA	NA	250.0	102	NA	120	80	NA
B205058-BS1	LCS	Soil/Sed	05/21/2012 08:16:00	05/21/2012 19:33:00	B205058	Manganese	250	1.00	2.00	mg/kg	1	NA	NA	250.0	99.9	NA	120	80	NA
B205058-BS1	LCS	Soil/Sed	05/21/2012 08:16:00	05/21/2012 19:33:00	B205058	Nickel	255	1.00	2.00	mg/kg	1	NA	NA	250.0	102	NA	120	80	NA
B205058-BS1	LCS	Soil/Sed	05/21/2012 08:16:00	05/21/2012 19:33:00	B205058	Phosphorus	237	1.00	2.00	mg/kg	1	NA	NA	250.0	95.0	NA	120	80	NA
B205058-BS1	LCS	Soil/Sed	05/21/2012 08:16:00	05/21/2012 19:33:00	B205058	Potassium	237	1.00	2.00	mg/kg	1	NA	NA	250.0	94.9	NA	120	80	NA
B205058-BS1	LCS	Soil/Sed	05/21/2012 08:16:00	05/21/2012 19:33:00	B205058	Selenium	243	1.00	2.00	mg/kg	1	NA	NA	250.0	97.4	NA	120	80	NA
B205058-BS1	LCS	Soil/Sed	05/21/2012 08:16:00	05/21/2012 19:33:00	B205058	Antimony	244	1.00	2.00	mg/kg	1	NA	NA	250.0	97.6	NA	120	80	NA
B205058-BS1	LCS	Soil/Sed	05/21/2012 08:16:00	05/21/2012 19:33:00	B205058	Silver	245	1.00	2.00	mg/kg	1	NA	NA	250.0	97.9	NA	120	80	NA
B205058-BS1	LCS	Soil/Sed	05/21/2012 08:16:00	05/21/2012 19:33:00	B205058	Sodium	248	1.00	2.00	mg/kg	1	NA	NA	250.0	99.1	NA	120	80	NA
B205058-BS1	LCS	Soil/Sed	05/21/2012 08:16:00	05/21/2012 19:33:00	B205058	Thallium	255	1.00	2.00	mg/kg	1	NA	NA	250.0	102	NA	120	80	NA
B205058-BS1	LCS	Soil/Sed	05/21/2012 08:16:00	05/21/2012 19:33:00	B205058	Vanadium	242	1.00	2.00	mg/kg	1	NA	NA	250.0	96.9	NA	120	80	NA
B205058-BS1	LCS	Soil/Sed	05/21/2012 08:16:00	05/21/2012 19:33:00	B205058	Zinc	256	1.00	2.00	mg/kg	1	NA	NA	250.0	102	NA	120	80	NA
B205058-BS1	LCS	Soil/Sed	05/21/2012 08:16:00	05/21/2012 19:33:00	B205058	Arsenic	243	1.00	2.00	mg/kg	1	NA	NA	250.0	97.3	NA	120	80	NA
B205058-BS1	LCS	Soil/Sed	05/21/2012 08:16:00	05/21/2012 19:33:00	B205058	Barium	243	1.00	2.00	mg/kg	1	NA	NA	250.0	97.4	NA	120	80	NA
B205058-BS1	LCS	Soil/Sed	05/21/2012 08:16:00	05/21/2012 19:33:00	B205058	Beryllium	248	1.00	2.00	mg/kg	1	NA	NA	250.0	99.1	NA	120	80	NA

SAMPID	TYPE	MATRIX	PREPDATE	ANADATE	BATCH	ANALYTE	RESULT	DL	RL	UNITS	DIL	SORC ID	SORC RES	SPIKE LVL	REC	RPD	U CL	L CL	RPDCL
B205058-BS1	LCS	Soil/Sed	05/21/2012 08:16:00	05/21/2012 19:33:00	B205058	Cadmium	199	1.00	2.00	mg/kg	1	NA	NA	250.0	79.7	NA	120	80	NA
B205058-BS1	LCS	Soil/Sed	05/21/2012 08:16:00	05/21/2012 19:33:00	B205058	Calcium	248	1.00	2.00	mg/kg	1	NA	NA	250.0	99.4	NA	120	80	NA
B205058-BS1	LCS	Soil/Sed	05/21/2012 08:16:00	05/21/2012 19:33:00	B205058	Chromium	252	1.00	2.00	mg/kg	1	NA	NA	250.0	101	NA	120	80	NA
B205058-BS1	LCS	Soil/Sed	05/21/2012 08:16:00	05/21/2012 19:33:00	B205058	Cobalt	249	1.00	2.00	mg/kg	1	NA	NA	250.0	99.7	NA	120	80	NA
B207045-BLK1	Blank	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Aluminum	ND	0.0200	0.0400	mg/L	2	NA	NA	NA	NA	NA	NA	NA	NA
B207045-BLK1	Blank	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Cobalt	ND	0.0200	0.0400	mg/L	2	NA	NA	NA	NA	NA	NA	NA	NA
B207045-BLK1	Blank	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Copper	ND	0.0200	0.0400	mg/L	2	NA	NA	NA	NA	NA	NA	NA	NA
B207045-BLK1	Blank	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Iron	ND	0.0200	0.0400	mg/L	2	NA	NA	NA	NA	NA	NA	NA	NA
B207045-BLK1	Blank	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Lead	ND	0.0200	0.0400	mg/L	2	NA	NA	NA	NA	NA	NA	NA	NA
B207045-BLK1	Blank	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Magnesium	ND	0.0200	0.0400	mg/L	2	NA	NA	NA	NA	NA	NA	NA	NA
B207045-BLK1	Blank	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Manganese	ND	0.0200	0.0400	mg/L	2	NA	NA	NA	NA	NA	NA	NA	NA
B207045-BLK1	Blank	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Nickel	ND	0.0200	0.0400	mg/L	2	NA	NA	NA	NA	NA	NA	NA	NA
B207045-BLK1	Blank	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Phosphorus	ND	0.0200	0.0400	mg/L	2	NA	NA	NA	NA	NA	NA	NA	NA
B207045-BLK1	Blank	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Potassium	ND	0.0200	0.0400	mg/L	2	NA	NA	NA	NA	NA	NA	NA	NA
B207045-BLK1	Blank	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Antimony	ND	0.0200	0.0400	mg/L	2	NA	NA	NA	NA	NA	NA	NA	NA
B207045-BLK1	Blank	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Selenium	ND	0.0200	0.0400	mg/L	2	NA	NA	NA	NA	NA	NA	NA	NA
B207045-BLK1	Blank	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Silver	ND	0.0200	0.0400	mg/L	2	NA	NA	NA	NA	NA	NA	NA	NA
B207045-BLK1	Blank	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Sodium	ND	0.0200	0.0400	mg/L	2	NA	NA	NA	NA	NA	NA	NA	NA

SAMPID	TYPE	MATRIX	PREPDATE	ANADATE	BATCH	ANALYTE	RESULT	DL	RL	UNITS	DIL	SORC ID	SORC RES	SPIKE LVL	REC	RPD	U CL	L CL	RPDCL
B207045-BLK1	Blank	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Thallium	ND	0.0200	0.0400	mg/L	2	NA	NA	NA	NA	NA	NA	NA	NA
B207045-BLK1	Blank	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Arsenic	ND	0.0200	0.0400	mg/L	2	NA	NA	NA	NA	NA	NA	NA	NA
B207045-BLK1	Blank	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Vanadium	ND	0.0200	0.0400	mg/L	2	NA	NA	NA	NA	NA	NA	NA	NA
B207045-BLK1	Blank	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Zinc	ND	0.0200	0.0400	mg/L	2	NA	NA	NA	NA	NA	NA	NA	NA
B207045-BLK1	Blank	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Barium	ND	0.0200	0.0400	mg/L	2	NA	NA	NA	NA	NA	NA	NA	NA
B207045-BLK1	Blank	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Beryllium	ND	0.0200	0.0400	mg/L	2	NA	NA	NA	NA	NA	NA	NA	NA
B207045-BLK1	Blank	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Cadmium	ND	0.0200	0.0400	mg/L	2	NA	NA	NA	NA	NA	NA	NA	NA
B207045-BLK1	Blank	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Calcium	ND	0.0200	0.0400	mg/L	2	NA	NA	NA	NA	NA	NA	NA	NA
B207045-BLK1	Blank	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Chromium	ND	0.0200	0.0400	mg/L	2	NA	NA	NA	NA	NA	NA	NA	NA
B207045-BS1	LCS	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Aluminum	2.45	0.0200	0.0400	mg/L	2	NA	NA	2.500	98.1	NA	120	80	NA
B207045-BS1	LCS	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Cobalt	2.50	0.0200	0.0400	mg/L	2	NA	NA	2.500	100	NA	120	80	NA
B207045-BS1	LCS	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Copper	2.52	0.0200	0.0400	mg/L	2	NA	NA	2.500	101	NA	120	80	NA
B207045-BS1	LCS	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Iron	2.58	0.0200	0.0400	mg/L	2	NA	NA	2.500	103	NA	120	80	NA
B207045-BS1	LCS	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Lead	2.52	0.0200	0.0400	mg/L	2	NA	NA	2.500	101	NA	120	80	NA
B207045-BS1	LCS	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Magnesium	2.51	0.0200	0.0400	mg/L	2	NA	NA	2.500	101	NA	120	80	NA
B207045-BS1	LCS	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Manganese	2.49	0.0200	0.0400	mg/L	2	NA	NA	2.500	99.6	NA	120	80	NA
B207045-BS1	LCS	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Nickel	2.55	0.0200	0.0400	mg/L	2	NA	NA	2.500	102	NA	120	80	NA
B207045-BS1	LCS	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Phosphorus	2.41	0.0200	0.0400	mg/L	2	NA	NA	2.500	96.6	NA	120	80	NA

SAMPID	TYPE	MATRIX	PREPDATE	ANADATE	BATCH	ANALYTE	RESULT	DL	RL	UNITS	DIL	SORC ID	SORC RES	SPIKE LVL	REC	RPD	U CL	L CL	RPDCL
B207045-BS1	LCS	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Potassium	2.37	0.0200	0.0400	mg/L	2	NA	NA	2.500	94.7	NA	120	80	NA
B207045-BS1	LCS	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Antimony	2.43	0.0200	0.0400	mg/L	2	NA	NA	2.500	97.1	NA	120	80	NA
B207045-BS1	LCS	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Selenium	2.43	0.0200	0.0400	mg/L	2	NA	NA	2.500	97.4	NA	120	80	NA
B207045-BS1	LCS	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Silver	2.44	0.0200	0.0400	mg/L	2	NA	NA	2.500	97.8	NA	120	80	NA
B207045-BS1	LCS	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Sodium	2.45	0.0200	0.0400	mg/L	2	NA	NA	2.500	97.8	NA	120	80	NA
B207045-BS1	LCS	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Thallium	2.53	0.0200	0.0400	mg/L	2	NA	NA	2.500	101	NA	120	80	NA
B207045-BS1	LCS	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Arsenic	2.43	0.0200	0.0400	mg/L	2	NA	NA	2.500	97.0	NA	120	80	NA
B207045-BS1	LCS	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Vanadium	2.43	0.0200	0.0400	mg/L	2	NA	NA	2.500	97.2	NA	120	80	NA
B207045-BS1	LCS	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Zinc	2.58	0.0200	0.0400	mg/L	2	NA	NA	2.500	103	NA	120	80	NA
B207045-BS1	LCS	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Barium	2.45	0.0200	0.0400	mg/L	2	NA	NA	2.500	97.9	NA	120	80	NA
B207045-BS1	LCS	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Beryllium	2.46	0.0200	0.0400	mg/L	2	NA	NA	2.500	98.3	NA	120	80	NA
B207045-BS1	LCS	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Cadmium	1.95	0.0200	0.0400	mg/L	2	NA	NA	2.500	77.8	NA	120	80	NA
B207045-BS1	LCS	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Calcium	2.52	0.0200	0.0400	mg/L	2	NA	NA	2.500	101	NA	120	80	NA
B207045-BS1	LCS	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Chromium	2.53	0.0200	0.0400	mg/L	2	NA	NA	2.500	101	NA	120	80	NA
B207045-DUP1	Dup	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Aluminum	0.0562	0.0200	0.0400	mg/L	2	20510 01-01	0.0552	NA	NA	1.79	NA	NA	20
B207045-DUP1	Dup	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Cobalt	ND	0.0200	0.0400	mg/L	2	20510 01-01	ND	NA	NA		NA	NA	20
B207045-DUP1	Dup	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Copper	0.0401	0.0200	0.0400	mg/L	2	20510 01-01	0.0488	NA	NA	19.8	NA	NA	20
B207045-DUP1	Dup	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Iron	0.333	0.0200	0.0400	mg/L	2	20510 01-01	0.333	NA	NA	0.0736	NA	NA	20

SAMPID	TYPE	MATRIX	PREPDATE	ANADATE	BATCH	ANALYTE	RESULT	DL	RL	UNITS	DIL	SORC ID	SORC RES	SPIKE LVL	REC	RPD	U CL	L CL	RPDCL
B207045-DUP1	Dup	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Lead	ND	0.0200	0.0400	mg/L	2	2051001-01	0.0240	NA	NA		NA	NA	20
B207045-DUP1	Dup	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Magnesium	0.163	0.0200	0.0400	mg/L	2	2051001-01	0.147	NA	NA	10.1	NA	NA	20
B207045-DUP1	Dup	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Manganese	0.0238	0.0200	0.0400	mg/L	2	2051001-01	0.0241	NA	NA	1.31	NA	NA	20
B207045-DUP1	Dup	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Nickel	0.106	0.0200	0.0400	mg/L	2	2051001-01	0.109	NA	NA	2.85	NA	NA	20
B207045-DUP1	Dup	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Phosphorus	ND	0.0200	0.0400	mg/L	2	2051001-01	ND	NA	NA		NA	NA	20
B207045-DUP1	Dup	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Potassium	0.289	0.0200	0.0400	mg/L	2	2051001-01	0.390	NA	NA	29.7	NA	NA	20
B207045-DUP1	Dup	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Antimony	ND	0.0200	0.0400	mg/L	2	2051001-01	0.0285	NA	NA		NA	NA	20
B207045-DUP1	Dup	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Selenium	ND	0.0200	0.0400	mg/L	2	2051001-01	ND	NA	NA		NA	NA	20
B207045-DUP1	Dup	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Silver	ND	0.0200	0.0400	mg/L	2	2051001-01	0.0220	NA	NA		NA	NA	20
B207045-DUP1	Dup	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Sodium	0.141	0.0200	0.0400	mg/L	2	2051001-01	0.177	NA	NA	22.5	NA	NA	20
B207045-DUP1	Dup	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Thallium	ND	0.0200	0.0400	mg/L	2	2051001-01	ND	NA	NA		NA	NA	20
B207045-DUP1	Dup	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Arsenic	ND	0.0200	0.0400	mg/L	2	2051001-01	ND	NA	NA		NA	NA	20
B207045-DUP1	Dup	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Vanadium	ND	0.0200	0.0400	mg/L	2	2051001-01	ND	NA	NA		NA	NA	20
B207045-DUP1	Dup	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Zinc	0.0442	0.0200	0.0400	mg/L	2	2051001-01	0.0757	NA	NA	52.5	NA	NA	20
B207045-DUP1	Dup	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Barium	ND	0.0200	0.0400	mg/L	2	2051001-01	ND	NA	NA		NA	NA	20
B207045-DUP1	Dup	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Beryllium	ND	0.0200	0.0400	mg/L	2	2051001-01	ND	NA	NA		NA	NA	20
B207045-DUP1	Dup	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Cadmium	ND	0.0200	0.0400	mg/L	2	2051001-01	0.0315	NA	NA		NA	NA	20
B207045-DUP1	Dup	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Calcium	0.265	0.0200	0.0400	mg/L	2	2051001-01	0.278	NA	NA	4.78	NA	NA	20

SAMPID	TYPE	MATRIX	PREPDATE	ANADATE	BATCH	ANALYTE	RESULT	DL	RL	UNITS	DIL	SORC ID	SORC RES	SPIKE LVL	REC	RPD	U CL	L CL	RPDCL
B207045-DUP1	Dup	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Chromium	0.0896	0.0200	0.0400	mg/L	2	20510 01-01	0.0927	NA	NA	3.49	NA	NA	20
B207045-DUP2	Dup	Water	05/22/2012 00:00:00	05/25/2012 16:10:00	B207045	Aluminum	0.0535	0.0200	0.0400	mg/L	2	20525 01-01	0.0354	NA	NA	40.7	NA	NA	20
B207045-DUP2	Dup	Water	05/22/2012 00:00:00	05/25/2012 16:10:00	B207045	Cobalt	ND	0.0200	0.0400	mg/L	2	20525 01-01	ND	NA	NA		NA	NA	20
B207045-DUP2	Dup	Water	05/22/2012 00:00:00	05/25/2012 16:10:00	B207045	Copper	0.0451	0.0200	0.0400	mg/L	2	20525 01-01	0.0653	NA	NA	36.7	NA	NA	20
B207045-DUP2	Dup	Water	05/22/2012 00:00:00	05/25/2012 16:10:00	B207045	Iron	0.0995	0.0200	0.0400	mg/L	2	20525 01-01	0.0801	NA	NA	21.6	NA	NA	20
B207045-DUP2	Dup	Water	05/22/2012 00:00:00	05/25/2012 16:10:00	B207045	Lead	0.0710	0.0200	0.0400	mg/L	2	20525 01-01	0.196	NA	NA	93.8	NA	NA	20
B207045-DUP2	Dup	Water	05/22/2012 00:00:00	05/25/2012 16:10:00	B207045	Magnesium	0.192	0.0200	0.0400	mg/L	2	20525 01-01	0.135	NA	NA	34.6	NA	NA	20
B207045-DUP2	Dup	Water	05/22/2012 00:00:00	05/25/2012 16:10:00	B207045	Manganese	ND	0.0200	0.0400	mg/L	2	20525 01-01	ND	NA	NA		NA	NA	20
B207045-DUP2	Dup	Water	05/22/2012 00:00:00	05/25/2012 16:10:00	B207045	Nickel	ND	0.0200	0.0400	mg/L	2	20525 01-01	ND	NA	NA		NA	NA	20
B207045-DUP2	Dup	Water	05/22/2012 00:00:00	05/25/2012 16:10:00	B207045	Phosphorus	0.0495	0.0200	0.0400	mg/L	2	20525 01-01	0.0708	NA	NA	35.5	NA	NA	20
B207045-DUP2	Dup	Water	05/22/2012 00:00:00	05/25/2012 16:10:00	B207045	Potassium	0.516	0.0200	0.0400	mg/L	2	20525 01-01	0.488	NA	NA	5.57	NA	NA	20
B207045-DUP2	Dup	Water	05/22/2012 00:00:00	05/25/2012 16:10:00	B207045	Antimony	0.0687	0.0200	0.0400	mg/L	2	20525 01-01	0.152	NA	NA	75.5	NA	NA	20
B207045-DUP2	Dup	Water	05/22/2012 00:00:00	05/25/2012 16:10:00	B207045	Selenium	ND	0.0200	0.0400	mg/L	2	20525 01-01	ND	NA	NA		NA	NA	20
B207045-DUP2	Dup	Water	05/22/2012 00:00:00	05/25/2012 16:10:00	B207045	Silver	ND	0.0200	0.0400	mg/L	2	20525 01-01	0.0208	NA	NA		NA	NA	20
B207045-DUP2	Dup	Water	05/22/2012 00:00:00	05/25/2012 16:10:00	B207045	Sodium	0.478	0.0200	0.0400	mg/L	2	20525 01-01	0.455	NA	NA	4.91	NA	NA	20
B207045-DUP2	Dup	Water	05/22/2012 00:00:00	05/25/2012 16:10:00	B207045	Thallium	ND	0.0200	0.0400	mg/L	2	20525 01-01	ND	NA	NA		NA	NA	20
B207045-DUP2	Dup	Water	05/22/2012 00:00:00	05/25/2012 16:10:00	B207045	Arsenic	ND	0.0200	0.0400	mg/L	2	20525 01-01	ND	NA	NA		NA	NA	20
B207045-DUP2	Dup	Water	05/22/2012 00:00:00	05/25/2012 16:10:00	B207045	Vanadium	ND	0.0200	0.0400	mg/L	2	20525 01-01	ND	NA	NA		NA	NA	20

SAMPID	TYPE	MATRIX	PREPDATE	ANADATE	BATCH	ANALYTE	RESULT	DL	RL	UNITS	DIL	SORC ID	SORC RES	SPIKE LVL	REC	RPD	U CL	L CL	RPDCL
B207045-DUP2	Dup	Water	05/22/2012 00:00:00	05/25/2012 16:10:00	B207045	Zinc	0.0589	0.0200	0.0400	mg/L	2	20525 01-01	0.0922	NA	NA	44.1	NA	NA	20
B207045-DUP2	Dup	Water	05/22/2012 00:00:00	05/25/2012 16:10:00	B207045	Barium	ND	0.0200	0.0400	mg/L	2	20525 01-01	ND	NA	NA		NA	NA	20
B207045-DUP2	Dup	Water	05/22/2012 00:00:00	05/25/2012 16:10:00	B207045	Beryllium	ND	0.0200	0.0400	mg/L	2	20525 01-01	ND	NA	NA		NA	NA	20
B207045-DUP2	Dup	Water	05/22/2012 00:00:00	05/25/2012 16:10:00	B207045	Cadmium	ND	0.0200	0.0400	mg/L	2	20525 01-01	ND	NA	NA		NA	NA	20
B207045-DUP2	Dup	Water	05/22/2012 00:00:00	05/25/2012 16:10:00	B207045	Calcium	0.275	0.0200	0.0400	mg/L	2	20525 01-01	0.248	NA	NA	10.4	NA	NA	20
B207045-DUP2	Dup	Water	05/22/2012 00:00:00	05/25/2012 16:10:00	B207045	Chromium	ND	0.0200	0.0400	mg/L	2	20525 01-01	ND	NA	NA		NA	NA	20
B207045-MS1	Matrix Spike	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Aluminum	1.98	0.0200	0.0400	mg/L	2	20510 01-01	0.0552	2.000	96.4	NA	120	80	NA
B207045-MS1	Matrix Spike	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Cobalt	2.00	0.0200	0.0400	mg/L	2	20510 01-01	ND	2.000	99.9	NA	120	80	NA
B207045-MS1	Matrix Spike	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Copper	2.05	0.0200	0.0400	mg/L	2	20510 01-01	0.0488	2.000	100	NA	120	80	NA
B207045-MS1	Matrix Spike	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Iron	2.40	0.0200	0.0400	mg/L	2	20510 01-01	0.333	2.000	103	NA	120	80	NA
B207045-MS1	Matrix Spike	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Lead	1.97	0.0200	0.0400	mg/L	2	20510 01-01	0.0240	2.000	97.1	NA	120	80	NA
B207045-MS1	Matrix Spike	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Magnesium	2.12	0.0200	0.0400	mg/L	2	20510 01-01	0.147	2.000	98.8	NA	120	80	NA
B207045-MS1	Matrix Spike	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Manganese	2.06	0.0200	0.0400	mg/L	2	20510 01-01	0.0241	2.000	102	NA	120	80	NA
B207045-MS1	Matrix Spike	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Nickel	2.12	0.0200	0.0400	mg/L	2	20510 01-01	0.109	2.000	100	NA	120	80	NA
B207045-MS1	Matrix Spike	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Phosphorus	1.84	0.0200	0.0400	mg/L	2	20510 01-01	ND	2.000	91.8	NA	120	80	NA
B207045-MS1	Matrix Spike	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Potassium	2.10	0.0200	0.0400	mg/L	2	20510 01-01	0.390	2.000	85.7	NA	120	80	NA
B207045-MS1	Matrix Spike	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Antimony	1.85	0.0200	0.0400	mg/L	2	20510 01-01	0.0285	2.000	91.2	NA	120	80	NA
B207045-MS1	Matrix Spike	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Selenium	1.82	0.0200	0.0400	mg/L	2	20510 01-01	ND	2.000	91.2	NA	120	80	NA

SAMPID	TYPE	MATRIX	PREPDATE	ANADATE	BATCH	ANALYTE	RESULT	DL	RL	UNITS	DIL	SORC ID	SORC RES	SPIKE LVL	REC	RPD	U CL	L CL	RPDCL
B207045-MS1	Matrix Spike	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Silver	1.88	0.0200	0.0400	mg/L	2	2051001-01	0.0220	2.000	93.0	NA	120	80	NA
B207045-MS1	Matrix Spike	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Sodium	2.05	0.0200	0.0400	mg/L	2	2051001-01	0.177	2.000	93.7	NA	120	80	NA
B207045-MS1	Matrix Spike	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Thallium	1.96	0.0200	0.0400	mg/L	2	2051001-01	ND	2.000	98.2	NA	120	80	NA
B207045-MS1	Matrix Spike	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Arsenic	1.88	0.0200	0.0400	mg/L	2	2051001-01	ND	2.000	94.2	NA	120	80	NA
B207045-MS1	Matrix Spike	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Vanadium	1.95	0.0200	0.0400	mg/L	2	2051001-01	ND	2.000	97.3	NA	120	80	NA
B207045-MS1	Matrix Spike	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Zinc	1.95	0.0200	0.0400	mg/L	2	2051001-01	0.0757	2.000	93.6	NA	120	80	NA
B207045-MS1	Matrix Spike	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Barium	1.93	0.0200	0.0400	mg/L	2	2051001-01	ND	2.000	96.6	NA	120	80	NA
B207045-MS1	Matrix Spike	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Beryllium	1.95	0.0200	0.0400	mg/L	2	2051001-01	ND	2.000	97.6	NA	120	80	NA
B207045-MS1	Matrix Spike	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Cadmium	1.96	0.0200	0.0400	mg/L	2	2051001-01	0.0315	2.000	96.4	NA	120	80	NA
B207045-MS1	Matrix Spike	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Calcium	2.28	0.0200	0.0400	mg/L	2	2051001-01	0.278	2.000	99.9	NA	120	80	NA
B207045-MS1	Matrix Spike	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Chromium	2.13	0.0200	0.0400	mg/L	2	2051001-01	0.0927	2.000	102	NA	120	80	NA
B207045-MS2	Matrix Spike	Water	05/22/2012 00:00:00	05/25/2012 16:10:00	B207045	Aluminum	2.09	0.0200	0.0400	mg/L	2	2052501-01	0.0354	2.000	103	NA	120	80	NA
B207045-MS2	Matrix Spike	Water	05/22/2012 00:00:00	05/25/2012 16:10:00	B207045	Cobalt	2.06	0.0200	0.0400	mg/L	2	2052501-01	ND	2.000	103	NA	120	80	NA
B207045-MS2	Matrix Spike	Water	05/22/2012 00:00:00	05/25/2012 16:10:00	B207045	Copper	2.15	0.0200	0.0400	mg/L	2	2052501-01	0.0653	2.000	104	NA	120	80	NA
B207045-MS2	Matrix Spike	Water	05/22/2012 00:00:00	05/25/2012 16:10:00	B207045	Iron	2.23	0.0200	0.0400	mg/L	2	2052501-01	0.0801	2.000	108	NA	120	80	NA
B207045-MS2	Matrix Spike	Water	05/22/2012 00:00:00	05/25/2012 16:10:00	B207045	Lead	2.06	0.0200	0.0400	mg/L	2	2052501-01	0.196	2.000	93.2	NA	120	80	NA
B207045-MS2	Matrix Spike	Water	05/22/2012 00:00:00	05/25/2012 16:10:00	B207045	Magnesium	2.25	0.0200	0.0400	mg/L	2	2052501-01	0.135	2.000	106	NA	120	80	NA
B207045-MS2	Matrix Spike	Water	05/22/2012 00:00:00	05/25/2012 16:10:00	B207045	Manganese	2.06	0.0200	0.0400	mg/L	2	2052501-01	ND	2.000	103	NA	120	80	NA

SAMPID	TYPE	MATRIX	PREPDATE	ANADATE	BATCH	ANALYTE	RESULT	DL	RL	UNITS	DIL	SORC ID	SORC RES	SPIKE LVL	REC	RPD	U CL	L CL	RPDCL
B207045-MS2	Matrix Spike	Water	05/22/2012 00:00:00	05/25/2012 16:10:00	B207045	Nickel	2.07	0.0200	0.0400	mg/L	2	20525 01-01	ND	2.000	103	NA	120	80	NA
B207045-MS2	Matrix Spike	Water	05/22/2012 00:00:00	05/25/2012 16:10:00	B207045	Phosphorus	1.94	0.0200	0.0400	mg/L	2	20525 01-01	0.0708	2.000	93.2	NA	120	80	NA
B207045-MS2	Matrix Spike	Water	05/22/2012 00:00:00	05/25/2012 16:10:00	B207045	Potassium	2.43	0.0200	0.0400	mg/L	2	20525 01-01	0.488	2.000	96.9	NA	120	80	NA
B207045-MS2	Matrix Spike	Water	05/22/2012 00:00:00	05/25/2012 16:10:00	B207045	Antimony	1.97	0.0200	0.0400	mg/L	2	20525 01-01	0.152	2.000	90.8	NA	120	80	NA
B207045-MS2	Matrix Spike	Water	05/22/2012 00:00:00	05/25/2012 16:10:00	B207045	Selenium	1.92	0.0200	0.0400	mg/L	2	20525 01-01	ND	2.000	96.1	NA	120	80	NA
B207045-MS2	Matrix Spike	Water	05/22/2012 00:00:00	05/25/2012 16:10:00	B207045	Silver	1.97	0.0200	0.0400	mg/L	2	20525 01-01	0.0208	2.000	97.6	NA	120	80	NA
B207045-MS2	Matrix Spike	Water	05/22/2012 00:00:00	05/25/2012 16:10:00	B207045	Sodium	2.48	0.0200	0.0400	mg/L	2	20525 01-01	0.455	2.000	101	NA	120	80	NA
B207045-MS2	Matrix Spike	Water	05/22/2012 00:00:00	05/25/2012 16:10:00	B207045	Thallium	2.05	0.0200	0.0400	mg/L	2	20525 01-01	ND	2.000	102	NA	120	80	NA
B207045-MS2	Matrix Spike	Water	05/22/2012 00:00:00	05/25/2012 16:10:00	B207045	Arsenic	1.94	0.0200	0.0400	mg/L	2	20525 01-01	ND	2.000	97.2	NA	120	80	NA
B207045-MS2	Matrix Spike	Water	05/22/2012 00:00:00	05/25/2012 16:10:00	B207045	Vanadium	2.01	0.0200	0.0400	mg/L	2	20525 01-01	ND	2.000	100	NA	120	80	NA
B207045-MS2	Matrix Spike	Water	05/22/2012 00:00:00	05/25/2012 16:10:00	B207045	Zinc	2.02	0.0200	0.0400	mg/L	2	20525 01-01	0.0922	2.000	96.4	NA	120	80	NA
B207045-MS2	Matrix Spike	Water	05/22/2012 00:00:00	05/25/2012 16:10:00	B207045	Barium	2.03	0.0200	0.0400	mg/L	2	20525 01-01	ND	2.000	101	NA	120	80	NA
B207045-MS2	Matrix Spike	Water	05/22/2012 00:00:00	05/25/2012 16:10:00	B207045	Beryllium	2.07	0.0200	0.0400	mg/L	2	20525 01-01	ND	2.000	104	NA	120	80	NA
B207045-MS2	Matrix Spike	Water	05/22/2012 00:00:00	05/25/2012 16:10:00	B207045	Cadmium	2.03	0.0200	0.0400	mg/L	2	20525 01-01	ND	2.000	102	NA	120	80	NA
B207045-MS2	Matrix Spike	Water	05/22/2012 00:00:00	05/25/2012 16:10:00	B207045	Calcium	2.34	0.0200	0.0400	mg/L	2	20525 01-01	0.248	2.000	104	NA	120	80	NA
B207045-MS2	Matrix Spike	Water	05/22/2012 00:00:00	05/25/2012 16:10:00	B207045	Chromium	2.10	0.0200	0.0400	mg/L	2	20525 01-01	ND	2.000	105	NA	120	80	NA
B205075-BLK1	Blank	Soil/Sed	05/22/2012 14:39:00	05/24/2012 15:11:00	B205075	Aluminum	ND	1.00	2.00	mg/kg	1	NA	NA	NA	NA	NA	NA	NA	NA
B205075-BLK1	Blank	Soil/Sed	05/22/2012 14:39:00	05/24/2012 15:11:00	B205075	Copper	ND	1.00	2.00	mg/kg	1	NA	NA	NA	NA	NA	NA	NA	NA

SAMPID	TYPE	MATRIX	PREPDATE	ANADATE	BATCH	ANALYTE	RESULT	DL	RL	UNITS	DIL	SORC ID	SORC RES	SPIKE LVL	REC	RPD	U CL	L CL	RPDCL
B205075-BLK1	Blank	Soil/Sed	05/22/2012 14:39:00	05/24/2012 15:11:00	B205075	Iron	ND	1.00	2.00	mg/kg	1	NA	NA	NA	NA	NA	NA	NA	NA
B205075-BLK1	Blank	Soil/Sed	05/22/2012 14:39:00	05/24/2012 15:11:00	B205075	Lead	ND	1.00	2.00	mg/kg	1	NA	NA	NA	NA	NA	NA	NA	NA
B205075-BLK1	Blank	Soil/Sed	05/22/2012 14:39:00	05/24/2012 15:11:00	B205075	Magnesium	2.66	1.00	2.00	mg/kg	1	NA	NA	NA	NA	NA	NA	NA	NA
B205075-BLK1	Blank	Soil/Sed	05/22/2012 14:39:00	05/24/2012 15:11:00	B205075	Manganese	ND	1.00	2.00	mg/kg	1	NA	NA	NA	NA	NA	NA	NA	NA
B205075-BLK1	Blank	Soil/Sed	05/22/2012 14:39:00	05/24/2012 15:11:00	B205075	Nickel	ND	1.00	2.00	mg/kg	1	NA	NA	NA	NA	NA	NA	NA	NA
B205075-BLK1	Blank	Soil/Sed	05/22/2012 14:39:00	05/24/2012 15:11:00	B205075	Phosphorus	ND	1.00	2.00	mg/kg	1	NA	NA	NA	NA	NA	NA	NA	NA
B205075-BLK1	Blank	Soil/Sed	05/22/2012 14:39:00	05/24/2012 15:11:00	B205075	Potassium	ND	1.00	2.00	mg/kg	1	NA	NA	NA	NA	NA	NA	NA	NA
B205075-BLK1	Blank	Soil/Sed	05/22/2012 14:39:00	05/24/2012 15:11:00	B205075	Selenium	ND	1.00	2.00	mg/kg	1	NA	NA	NA	NA	NA	NA	NA	NA
B205075-BLK1	Blank	Soil/Sed	05/22/2012 14:39:00	05/24/2012 15:11:00	B205075	Antimony	ND	1.00	2.00	mg/kg	1	NA	NA	NA	NA	NA	NA	NA	NA
B205075-BLK1	Blank	Soil/Sed	05/22/2012 14:39:00	05/24/2012 15:11:00	B205075	Silver	ND	1.00	2.00	mg/kg	1	NA	NA	NA	NA	NA	NA	NA	NA
B205075-BLK1	Blank	Soil/Sed	05/22/2012 14:39:00	05/24/2012 15:11:00	B205075	Sodium	ND	1.00	2.00	mg/kg	1	NA	NA	NA	NA	NA	NA	NA	NA
B205075-BLK1	Blank	Soil/Sed	05/22/2012 14:39:00	05/24/2012 15:11:00	B205075	Thallium	ND	1.00	2.00	mg/kg	1	NA	NA	NA	NA	NA	NA	NA	NA
B205075-BLK1	Blank	Soil/Sed	05/22/2012 14:39:00	05/24/2012 15:11:00	B205075	Vanadium	ND	1.00	2.00	mg/kg	1	NA	NA	NA	NA	NA	NA	NA	NA
B205075-BLK1	Blank	Soil/Sed	05/22/2012 14:39:00	05/24/2012 15:11:00	B205075	Zinc	ND	1.00	2.00	mg/kg	1	NA	NA	NA	NA	NA	NA	NA	NA
B205075-BLK1	Blank	Soil/Sed	05/22/2012 14:39:00	05/24/2012 15:11:00	B205075	Arsenic	ND	1.00	2.00	mg/kg	1	NA	NA	NA	NA	NA	NA	NA	NA
B205075-BLK1	Blank	Soil/Sed	05/22/2012 14:39:00	05/24/2012 15:11:00	B205075	Barium	ND	1.00	2.00	mg/kg	1	NA	NA	NA	NA	NA	NA	NA	NA
B205075-BLK1	Blank	Soil/Sed	05/22/2012 14:39:00	05/24/2012 15:11:00	B205075	Beryllium	ND	1.00	2.00	mg/kg	1	NA	NA	NA	NA	NA	NA	NA	NA
B205075-BLK1	Blank	Soil/Sed	05/22/2012 14:39:00	05/24/2012 15:11:00	B205075	Cadmium	ND	1.00	2.00	mg/kg	1	NA	NA	NA	NA	NA	NA	NA	NA

SAMPID	TYPE	MATRIX	PREPDATE	ANADATE	BATCH	ANALYTE	RESULT	DL	RL	UNITS	DIL	SORC ID	SORC RES	SPIKE LVL	REC	RPD	U CL	L CL	RPDCL
B205075-BLK1	Blank	Soil/Sed	05/22/2012 14:39:00	05/24/2012 15:11:00	B205075	Calcium	ND	1.00	2.00	mg/kg	1	NA	NA	NA	NA	NA	NA	NA	NA
B205075-BLK1	Blank	Soil/Sed	05/22/2012 14:39:00	05/24/2012 15:11:00	B205075	Chromium	ND	1.00	2.00	mg/kg	1	NA	NA	NA	NA	NA	NA	NA	NA
B205075-BLK1	Blank	Soil/Sed	05/22/2012 14:39:00	05/24/2012 15:11:00	B205075	Cobalt	ND	1.00	2.00	mg/kg	1	NA	NA	NA	NA	NA	NA	NA	NA
B205075-BS1	LCS	Soil/Sed	05/22/2012 14:39:00	05/24/2012 15:11:00	B205075	Aluminum	247	1.00	2.00	mg/kg	1	NA	NA	250.0	98.8	NA	120	80	NA
B205075-BS1	LCS	Soil/Sed	05/22/2012 14:39:00	05/24/2012 15:11:00	B205075	Copper	252	1.00	2.00	mg/kg	1	NA	NA	250.0	101	NA	120	80	NA
B205075-BS1	LCS	Soil/Sed	05/22/2012 14:39:00	05/24/2012 15:11:00	B205075	Iron	259	1.00	2.00	mg/kg	1	NA	NA	250.0	104	NA	120	80	NA
B205075-BS1	LCS	Soil/Sed	05/22/2012 14:39:00	05/24/2012 15:11:00	B205075	Lead	254	1.00	2.00	mg/kg	1	NA	NA	250.0	101	NA	120	80	NA
B205075-BS1	LCS	Soil/Sed	05/22/2012 14:39:00	05/24/2012 15:11:00	B205075	Magnesium	253	1.00	2.00	mg/kg	1	NA	NA	250.0	101	NA	120	80	NA
B205075-BS1	LCS	Soil/Sed	05/22/2012 14:39:00	05/24/2012 15:11:00	B205075	Manganese	252	1.00	2.00	mg/kg	1	NA	NA	250.0	101	NA	120	80	NA
B205075-BS1	LCS	Soil/Sed	05/22/2012 14:39:00	05/24/2012 15:11:00	B205075	Nickel	255	1.00	2.00	mg/kg	1	NA	NA	250.0	102	NA	120	80	NA
B205075-BS1	LCS	Soil/Sed	05/22/2012 14:39:00	05/24/2012 15:11:00	B205075	Phosphorus	244	1.00	2.00	mg/kg	1	NA	NA	250.0	97.6	NA	120	80	NA
B205075-BS1	LCS	Soil/Sed	05/22/2012 14:39:00	05/24/2012 15:11:00	B205075	Potassium	238	1.00	2.00	mg/kg	1	NA	NA	250.0	95.2	NA	120	80	NA
B205075-BS1	LCS	Soil/Sed	05/22/2012 14:39:00	05/24/2012 15:11:00	B205075	Selenium	244	1.00	2.00	mg/kg	1	NA	NA	250.0	97.4	NA	120	80	NA
B205075-BS1	LCS	Soil/Sed	05/22/2012 14:39:00	05/24/2012 15:11:00	B205075	Antimony	246	1.00	2.00	mg/kg	1	NA	NA	250.0	98.3	NA	120	80	NA
B205075-BS1	LCS	Soil/Sed	05/22/2012 14:39:00	05/24/2012 15:11:00	B205075	Silver	244	1.00	2.00	mg/kg	1	NA	NA	250.0	97.6	NA	120	80	NA
B205075-BS1	LCS	Soil/Sed	05/22/2012 14:39:00	05/24/2012 15:11:00	B205075	Sodium	253	1.00	2.00	mg/kg	1	NA	NA	250.0	101	NA	120	80	NA
B205075-BS1	LCS	Soil/Sed	05/22/2012 14:39:00	05/24/2012 15:11:00	B205075	Thallium	256	1.00	2.00	mg/kg	1	NA	NA	250.0	102	NA	120	80	NA
B205075-BS1	LCS	Soil/Sed	05/22/2012 14:39:00	05/24/2012 15:11:00	B205075	Vanadium	243	1.00	2.00	mg/kg	1	NA	NA	250.0	97.1	NA	120	80	NA

SAMPID	TYPE	MATRIX	PREPDATE	ANADATE	BATCH	ANALYTE	RESULT	DL	RL	UNITS	DIL	SORC ID	SORC RES	SPIKE LVL	REC	RPD	U CL	L CL	RPDCL
B205075-BS1	LCS	Soil/Sed	05/22/2012 14:39:00	05/24/2012 15:11:00	B205075	Zinc	256	1.00	2.00	mg/kg	1	NA	NA	250.0	103	NA	120	80	NA
B205075-BS1	LCS	Soil/Sed	05/22/2012 14:39:00	05/24/2012 15:11:00	B205075	Arsenic	245	1.00	2.00	mg/kg	1	NA	NA	250.0	98.0	NA	120	80	NA
B205075-BS1	LCS	Soil/Sed	05/22/2012 14:39:00	05/24/2012 15:11:00	B205075	Barium	245	1.00	2.00	mg/kg	1	NA	NA	250.0	98.2	NA	120	80	NA
B205075-BS1	LCS	Soil/Sed	05/22/2012 14:39:00	05/24/2012 15:11:00	B205075	Beryllium	249	1.00	2.00	mg/kg	1	NA	NA	250.0	99.5	NA	120	80	NA
B205075-BS1	LCS	Soil/Sed	05/22/2012 14:39:00	05/24/2012 15:11:00	B205075	Cadmium	202	1.00	2.00	mg/kg	1	NA	NA	250.0	80.8	NA	120	80	NA
B205075-BS1	LCS	Soil/Sed	05/22/2012 14:39:00	05/24/2012 15:11:00	B205075	Calcium	255	1.00	2.00	mg/kg	1	NA	NA	250.0	102	NA	120	80	NA
B205075-BS1	LCS	Soil/Sed	05/22/2012 14:39:00	05/24/2012 15:11:00	B205075	Chromium	250	1.00	2.00	mg/kg	1	NA	NA	250.0	100	NA	120	80	NA
B205075-BS1	LCS	Soil/Sed	05/22/2012 14:39:00	05/24/2012 15:11:00	B205075	Cobalt	250	1.00	2.00	mg/kg	1	NA	NA	250.0	99.8	NA	120	80	NA
B205075-DUP1	Dup	Soil/Sed	05/22/2012 14:39:00	05/24/2012 15:11:00	B205075	Aluminum	6190	2.00	4.00	mg/kg	2	2052202-01	6230	NA	NA	0.608	NA	NA	20
B205075-DUP1	Dup	Soil/Sed	05/22/2012 14:39:00	05/24/2012 15:11:00	B205075	Copper	62.8	2.00	4.00	mg/kg	2	2052202-01	63.0	NA	NA	0.286	NA	NA	20
B205075-DUP1	Dup	Soil/Sed	05/22/2012 14:39:00	05/24/2012 15:11:00	B205075	Iron	6370	2.00	4.00	mg/kg	2	2052202-01	6400	NA	NA	0.464	NA	NA	20
B205075-DUP1	Dup	Soil/Sed	05/22/2012 14:39:00	05/24/2012 15:11:00	B205075	Lead	589	2.00	4.00	mg/kg	2	2052202-01	592	NA	NA	0.633	NA	NA	20
B205075-DUP1	Dup	Soil/Sed	05/22/2012 14:39:00	05/24/2012 15:11:00	B205075	Magnesium	735	2.00	4.00	mg/kg	2	2052202-01	733	NA	NA	0.309	NA	NA	20
B205075-DUP1	Dup	Soil/Sed	05/22/2012 14:39:00	05/24/2012 15:11:00	B205075	Manganese	149	2.00	4.00	mg/kg	2	2052202-01	147	NA	NA	0.702	NA	NA	20
B205075-DUP1	Dup	Soil/Sed	05/22/2012 14:39:00	05/24/2012 15:11:00	B205075	Nickel	13.3	2.00	4.00	mg/kg	2	2052202-01	13.4	NA	NA	0.710	NA	NA	20
B205075-DUP1	Dup	Soil/Sed	05/22/2012 14:39:00	05/24/2012 15:11:00	B205075	Phosphorus	268	2.00	4.00	mg/kg	2	2052202-01	270	NA	NA	0.857	NA	NA	20
B205075-DUP1	Dup	Soil/Sed	05/22/2012 14:39:00	05/24/2012 15:11:00	B205075	Potassium	503	2.00	4.00	mg/kg	2	2052202-01	501	NA	NA	0.374	NA	NA	20
B205075-DUP1	Dup	Soil/Sed	05/22/2012 14:39:00	05/24/2012 15:11:00	B205075	Selenium	ND	2.00	4.00	mg/kg	2	2052202-01	ND	NA	NA		NA	NA	20

SAMPID	TYPE	MATRIX	PREPDATE	ANADATE	BATCH	ANALYTE	RESULT	DL	RL	UNITS	DIL	SORC ID	SORC RES	SPIKE LVL	REC	RPD	U CL	L CL	RPDCL
B205075-DUP1	Dup	Soil/Sed	05/22/2012 14:39:00	05/24/2012 15:11:00	B205075	Antimony	3.90	2.00	4.00	mg/kg	2	20522 02-01	5.41	NA	NA	32.6	NA	NA	20
B205075-DUP1	Dup	Soil/Sed	05/22/2012 14:39:00	05/24/2012 15:11:00	B205075	Silver	ND	2.00	4.00	mg/kg	2	20522 02-01	ND	NA	NA		NA	NA	20
B205075-DUP1	Dup	Soil/Sed	05/22/2012 14:39:00	05/24/2012 15:11:00	B205075	Sodium	36.3	2.00	4.00	mg/kg	2	20522 02-01	35.3	NA	NA	2.70	NA	NA	20
B205075-DUP1	Dup	Soil/Sed	05/22/2012 14:39:00	05/24/2012 15:11:00	B205075	Thallium	ND	2.00	4.00	mg/kg	2	20522 02-01	ND	NA	NA		NA	NA	20
B205075-DUP1	Dup	Soil/Sed	05/22/2012 14:39:00	05/24/2012 15:11:00	B205075	Vanadium	21.1	2.00	4.00	mg/kg	2	20522 02-01	21.2	NA	NA	0.409	NA	NA	20
B205075-DUP1	Dup	Soil/Sed	05/22/2012 14:39:00	05/24/2012 15:11:00	B205075	Zinc	31.2	2.00	4.00	mg/kg	2	20522 02-01	31.6	NA	NA	1.51	NA	NA	20
B205075-DUP1	Dup	Soil/Sed	05/22/2012 14:39:00	05/24/2012 15:11:00	B205075	Arsenic	2.12	2.00	4.00	mg/kg	2	20522 02-01	2.20	NA	NA	3.92	NA	NA	20
B205075-DUP1	Dup	Soil/Sed	05/22/2012 14:39:00	05/24/2012 15:11:00	B205075	Barium	43.2	2.00	4.00	mg/kg	2	20522 02-01	43.6	NA	NA	0.812	NA	NA	20
B205075-DUP1	Dup	Soil/Sed	05/22/2012 14:39:00	05/24/2012 15:11:00	B205075	Beryllium	ND	2.00	4.00	mg/kg	2	20522 02-01	ND	NA	NA		NA	NA	20
B205075-DUP1	Dup	Soil/Sed	05/22/2012 14:39:00	05/24/2012 15:11:00	B205075	Cadmium	ND	2.00	4.00	mg/kg	2	20522 02-01	ND	NA	NA		NA	NA	20
B205075-DUP1	Dup	Soil/Sed	05/22/2012 14:39:00	05/24/2012 15:11:00	B205075	Calcium	2590	2.00	4.00	mg/kg	2	20522 02-01	2610	NA	NA	0.793	NA	NA	20
B205075-DUP1	Dup	Soil/Sed	05/22/2012 14:39:00	05/24/2012 15:11:00	B205075	Chromium	8.59	2.00	4.00	mg/kg	2	20522 02-01	8.67	NA	NA	0.888	NA	NA	20
B205075-DUP1	Dup	Soil/Sed	05/22/2012 14:39:00	05/24/2012 15:11:00	B205075	Cobalt	2.41	2.00	4.00	mg/kg	2	20522 02-01	2.43	NA	NA	0.894	NA	NA	20
B205075-MS1	Matrix Spike	Soil/Sed	05/22/2012 14:39:00	05/24/2012 15:11:00	B205075	Aluminum	6110	2.00	4.00	mg/kg	2	20522 02-01	6230	40.00	-310	NA	120	80	NA
B205075-MS1	Matrix Spike	Soil/Sed	05/22/2012 14:39:00	05/24/2012 15:11:00	B205075	Copper	103	2.00	4.00	mg/kg	2	20522 02-01	63.0	40.00	99.3	NA	120	80	NA
B205075-MS1	Matrix Spike	Soil/Sed	05/22/2012 14:39:00	05/24/2012 15:11:00	B205075	Iron	6290	2.00	4.00	mg/kg	2	20522 02-01	6400	40.00	-270	NA	120	80	NA
B205075-MS1	Matrix Spike	Soil/Sed	05/22/2012 14:39:00	05/24/2012 15:11:00	B205075	Lead	613	2.00	4.00	mg/kg	2	20522 02-01	592	40.00	50.6	NA	120	80	NA
B205075-MS1	Matrix Spike	Soil/Sed	05/22/2012 14:39:00	05/24/2012 15:11:00	B205075	Magnesium	755	2.00	4.00	mg/kg	2	20522 02-01	733	40.00	57.0	NA	120	80	NA

SAMPID	TYPE	MATRIX	PREPDATE	ANADATE	BATCH	ANALYTE	RESULT	DL	RL	UNITS	DIL	SORC ID	SORC RES	SPIKE LVL	REC	RPD	U CL	L CL	RPDCL
B205075-MS1	Matrix Spike	Soil/Sed	05/22/2012 14:39:00	05/24/2012 15:11:00	B205075	Manganese	183	2.00	4.00	mg/kg	2	2052202-01	147	40.00	89.2	NA	120	80	NA
B205075-MS1	Matrix Spike	Soil/Sed	05/22/2012 14:39:00	05/24/2012 15:11:00	B205075	Nickel	49.1	2.00	4.00	mg/kg	2	2052202-01	13.4	40.00	89.2	NA	120	80	NA
B205075-MS1	Matrix Spike	Soil/Sed	05/22/2012 14:39:00	05/24/2012 15:11:00	B205075	Phosphorus	297	2.00	4.00	mg/kg	2	2052202-01	270	40.00	66.3	NA	120	80	NA
B205075-MS1	Matrix Spike	Soil/Sed	05/22/2012 14:39:00	05/24/2012 15:11:00	B205075	Potassium	521	2.00	4.00	mg/kg	2	2052202-01	501	40.00	50.4	NA	120	80	NA
B205075-MS1	Matrix Spike	Soil/Sed	05/22/2012 14:39:00	05/24/2012 15:11:00	B205075	Selenium	39.1	2.00	4.00	mg/kg	2	2052202-01	ND	40.00	97.8	NA	120	80	NA
B205075-MS1	Matrix Spike	Soil/Sed	05/22/2012 14:39:00	05/24/2012 15:11:00	B205075	Antimony	39.8	2.00	4.00	mg/kg	2	2052202-01	5.41	40.00	85.9	NA	120	80	NA
B205075-MS1	Matrix Spike	Soil/Sed	05/22/2012 14:39:00	05/24/2012 15:11:00	B205075	Silver	36.3	2.00	4.00	mg/kg	2	2052202-01	ND	40.00	90.9	NA	120	80	NA
B205075-MS1	Matrix Spike	Soil/Sed	05/22/2012 14:39:00	05/24/2012 15:11:00	B205075	Sodium	72.4	2.00	4.00	mg/kg	2	2052202-01	35.3	40.00	92.8	NA	120	80	NA
B205075-MS1	Matrix Spike	Soil/Sed	05/22/2012 14:39:00	05/24/2012 15:11:00	B205075	Thallium	34.9	2.00	4.00	mg/kg	2	2052202-01	ND	40.00	87.2	NA	120	80	NA
B205075-MS1	Matrix Spike	Soil/Sed	05/22/2012 14:39:00	05/24/2012 15:11:00	B205075	Vanadium	57.1	2.00	4.00	mg/kg	2	2052202-01	21.2	40.00	89.9	NA	120	80	NA
B205075-MS1	Matrix Spike	Soil/Sed	05/22/2012 14:39:00	05/24/2012 15:11:00	B205075	Zinc	65.6	2.00	4.00	mg/kg	2	2052202-01	31.6	40.00	84.8	NA	120	80	NA
B205075-MS1	Matrix Spike	Soil/Sed	05/22/2012 14:39:00	05/24/2012 15:11:00	B205075	Arsenic	40.4	2.00	4.00	mg/kg	2	2052202-01	2.20	40.00	95.5	NA	120	80	NA
B205075-MS1	Matrix Spike	Soil/Sed	05/22/2012 14:39:00	05/24/2012 15:11:00	B205075	Barium	79.4	2.00	4.00	mg/kg	2	2052202-01	43.6	40.00	89.5	NA	120	80	NA
B205075-MS1	Matrix Spike	Soil/Sed	05/22/2012 14:39:00	05/24/2012 15:11:00	B205075	Beryllium	38.6	2.00	4.00	mg/kg	2	2052202-01	ND	40.00	96.5	NA	120	80	NA
B205075-MS1	Matrix Spike	Soil/Sed	05/22/2012 14:39:00	05/24/2012 15:11:00	B205075	Cadmium	36.9	2.00	4.00	mg/kg	2	2052202-01	ND	40.00	92.1	NA	120	80	NA
B205075-MS1	Matrix Spike	Soil/Sed	05/22/2012 14:39:00	05/24/2012 15:11:00	B205075	Calcium	2580	2.00	4.00	mg/kg	2	2052202-01	2610	40.00	-67.4	NA	120	80	NA
B205075-MS1	Matrix Spike	Soil/Sed	05/22/2012 14:39:00	05/24/2012 15:11:00	B205075	Chromium	45.2	2.00	4.00	mg/kg	2	2052202-01	8.67	40.00	91.3	NA	120	80	NA
B205075-MS1	Matrix Spike	Soil/Sed	05/22/2012 14:39:00	05/24/2012 15:11:00	B205075	Cobalt	38.4	2.00	4.00	mg/kg	2	2052202-01	2.43	40.00	90.0	NA	120	80	NA

SAMPID	TYPE	MATRIX	PREPDATE	ANADATE	BATCH	ANALYTE	RESULT	DL	RL	UNITS	DIL	SORC ID	SORC RES	SPIKE LVL	REC	RPD	U CL	L CL	RPDCL
B207045-BLK1	Blank	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Aluminum	ND	0.0200	0.0400	mg/L	2	NA	NA	NA	NA	NA	NA	NA	NA
B207045-BLK1	Blank	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Cobalt	ND	0.0200	0.0400	mg/L	2	NA	NA	NA	NA	NA	NA	NA	NA
B207045-BLK1	Blank	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Copper	ND	0.0200	0.0400	mg/L	2	NA	NA	NA	NA	NA	NA	NA	NA
B207045-BLK1	Blank	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Iron	ND	0.0200	0.0400	mg/L	2	NA	NA	NA	NA	NA	NA	NA	NA
B207045-BLK1	Blank	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Lead	ND	0.0200	0.0400	mg/L	2	NA	NA	NA	NA	NA	NA	NA	NA
B207045-BLK1	Blank	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Magnesium	ND	0.0200	0.0400	mg/L	2	NA	NA	NA	NA	NA	NA	NA	NA
B207045-BLK1	Blank	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Manganese	ND	0.0200	0.0400	mg/L	2	NA	NA	NA	NA	NA	NA	NA	NA
B207045-BLK1	Blank	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Nickel	ND	0.0200	0.0400	mg/L	2	NA	NA	NA	NA	NA	NA	NA	NA
B207045-BLK1	Blank	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Phosphorus	ND	0.0200	0.0400	mg/L	2	NA	NA	NA	NA	NA	NA	NA	NA
B207045-BLK1	Blank	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Potassium	ND	0.0200	0.0400	mg/L	2	NA	NA	NA	NA	NA	NA	NA	NA
B207045-BLK1	Blank	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Antimony	ND	0.0200	0.0400	mg/L	2	NA	NA	NA	NA	NA	NA	NA	NA
B207045-BLK1	Blank	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Selenium	ND	0.0200	0.0400	mg/L	2	NA	NA	NA	NA	NA	NA	NA	NA
B207045-BLK1	Blank	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Silver	ND	0.0200	0.0400	mg/L	2	NA	NA	NA	NA	NA	NA	NA	NA
B207045-BLK1	Blank	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Sodium	ND	0.0200	0.0400	mg/L	2	NA	NA	NA	NA	NA	NA	NA	NA
B207045-BLK1	Blank	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Thallium	ND	0.0200	0.0400	mg/L	2	NA	NA	NA	NA	NA	NA	NA	NA
B207045-BLK1	Blank	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Arsenic	ND	0.0200	0.0400	mg/L	2	NA	NA	NA	NA	NA	NA	NA	NA
B207045-BLK1	Blank	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Vanadium	ND	0.0200	0.0400	mg/L	2	NA	NA	NA	NA	NA	NA	NA	NA
B207045-BLK1	Blank	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Zinc	ND	0.0200	0.0400	mg/L	2	NA	NA	NA	NA	NA	NA	NA	NA

SAMPID	TYPE	MATRIX	PREPDATE	ANADATE	BATCH	ANALYTE	RESULT	DL	RL	UNITS	DIL	SORC ID	SORC RES	SPIKE LVL	REC	RPD	U CL	L CL	RPDCL
B207045-BLK1	Blank	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Barium	ND	0.0200	0.0400	mg/L	2	NA	NA	NA	NA	NA	NA	NA	NA
B207045-BLK1	Blank	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Beryllium	ND	0.0200	0.0400	mg/L	2	NA	NA	NA	NA	NA	NA	NA	NA
B207045-BLK1	Blank	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Cadmium	ND	0.0200	0.0400	mg/L	2	NA	NA	NA	NA	NA	NA	NA	NA
B207045-BLK1	Blank	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Calcium	ND	0.0200	0.0400	mg/L	2	NA	NA	NA	NA	NA	NA	NA	NA
B207045-BLK1	Blank	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Chromium	ND	0.0200	0.0400	mg/L	2	NA	NA	NA	NA	NA	NA	NA	NA
B207045-BS1	LCS	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Aluminum	2.45	0.0200	0.0400	mg/L	2	NA	NA	2.500	98.1	NA	120	80	NA
B207045-BS1	LCS	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Cobalt	2.50	0.0200	0.0400	mg/L	2	NA	NA	2.500	100	NA	120	80	NA
B207045-BS1	LCS	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Copper	2.52	0.0200	0.0400	mg/L	2	NA	NA	2.500	101	NA	120	80	NA
B207045-BS1	LCS	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Iron	2.58	0.0200	0.0400	mg/L	2	NA	NA	2.500	103	NA	120	80	NA
B207045-BS1	LCS	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Lead	2.52	0.0200	0.0400	mg/L	2	NA	NA	2.500	101	NA	120	80	NA
B207045-BS1	LCS	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Magnesium	2.51	0.0200	0.0400	mg/L	2	NA	NA	2.500	101	NA	120	80	NA
B207045-BS1	LCS	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Manganese	2.49	0.0200	0.0400	mg/L	2	NA	NA	2.500	99.6	NA	120	80	NA
B207045-BS1	LCS	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Nickel	2.55	0.0200	0.0400	mg/L	2	NA	NA	2.500	102	NA	120	80	NA
B207045-BS1	LCS	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Phosphorus	2.41	0.0200	0.0400	mg/L	2	NA	NA	2.500	96.6	NA	120	80	NA
B207045-BS1	LCS	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Potassium	2.37	0.0200	0.0400	mg/L	2	NA	NA	2.500	94.7	NA	120	80	NA
B207045-BS1	LCS	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Antimony	2.43	0.0200	0.0400	mg/L	2	NA	NA	2.500	97.1	NA	120	80	NA
B207045-BS1	LCS	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Selenium	2.43	0.0200	0.0400	mg/L	2	NA	NA	2.500	97.4	NA	120	80	NA
B207045-BS1	LCS	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Silver	2.44	0.0200	0.0400	mg/L	2	NA	NA	2.500	97.8	NA	120	80	NA

SAMPID	TYPE	MATRIX	PREPDATE	ANADATE	BATCH	ANALYTE	RESULT	DL	RL	UNITS	DIL	SORC ID	SORC RES	SPIKE LVL	REC	RPD	U CL	L CL	RPDCL
B207045-BS1	LCS	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Sodium	2.45	0.0200	0.0400	mg/L	2	NA	NA	2.500	97.8	NA	120	80	NA
B207045-BS1	LCS	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Thallium	2.53	0.0200	0.0400	mg/L	2	NA	NA	2.500	101	NA	120	80	NA
B207045-BS1	LCS	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Arsenic	2.43	0.0200	0.0400	mg/L	2	NA	NA	2.500	97.0	NA	120	80	NA
B207045-BS1	LCS	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Vanadium	2.43	0.0200	0.0400	mg/L	2	NA	NA	2.500	97.2	NA	120	80	NA
B207045-BS1	LCS	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Zinc	2.58	0.0200	0.0400	mg/L	2	NA	NA	2.500	103	NA	120	80	NA
B207045-BS1	LCS	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Barium	2.45	0.0200	0.0400	mg/L	2	NA	NA	2.500	97.9	NA	120	80	NA
B207045-BS1	LCS	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Beryllium	2.46	0.0200	0.0400	mg/L	2	NA	NA	2.500	98.3	NA	120	80	NA
B207045-BS1	LCS	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Cadmium	1.95	0.0200	0.0400	mg/L	2	NA	NA	2.500	77.8	NA	120	80	NA
B207045-BS1	LCS	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Calcium	2.52	0.0200	0.0400	mg/L	2	NA	NA	2.500	101	NA	120	80	NA
B207045-BS1	LCS	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Chromium	2.53	0.0200	0.0400	mg/L	2	NA	NA	2.500	101	NA	120	80	NA
B207045-DUP1	Dup	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Aluminum	0.0562	0.0200	0.0400	mg/L	2	2051001-01	0.0552	NA	NA	1.79	NA	NA	20
B207045-DUP1	Dup	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Cobalt	ND	0.0200	0.0400	mg/L	2	2051001-01	ND	NA	NA		NA	NA	20
B207045-DUP1	Dup	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Copper	0.0401	0.0200	0.0400	mg/L	2	2051001-01	0.0488	NA	NA	19.8	NA	NA	20
B207045-DUP1	Dup	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Iron	0.333	0.0200	0.0400	mg/L	2	2051001-01	0.333	NA	NA	0.0736	NA	NA	20
B207045-DUP1	Dup	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Lead	ND	0.0200	0.0400	mg/L	2	2051001-01	0.0240	NA	NA		NA	NA	20
B207045-DUP1	Dup	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Magnesium	0.163	0.0200	0.0400	mg/L	2	2051001-01	0.147	NA	NA	10.1	NA	NA	20
B207045-DUP1	Dup	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Manganese	0.0238	0.0200	0.0400	mg/L	2	2051001-01	0.0241	NA	NA	1.31	NA	NA	20
B207045-DUP1	Dup	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Nickel	0.106	0.0200	0.0400	mg/L	2	2051001-01	0.109	NA	NA	2.85	NA	NA	20

SAMPID	TYPE	MATRIX	PREPDATE	ANADATE	BATCH	ANALYTE	RESULT	DL	RL	UNITS	DIL	SORC ID	SORC RES	SPIKE LVL	REC	RPD	U CL	L CL	RPDCL
B207045-DUP1	Dup	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Phosphorus	ND	0.0200	0.0400	mg/L	2	20510 01-01	ND	NA	NA		NA	NA	20
B207045-DUP1	Dup	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Potassium	0.289	0.0200	0.0400	mg/L	2	20510 01-01	0.390	NA	NA	29.7	NA	NA	20
B207045-DUP1	Dup	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Antimony	ND	0.0200	0.0400	mg/L	2	20510 01-01	0.0285	NA	NA		NA	NA	20
B207045-DUP1	Dup	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Selenium	ND	0.0200	0.0400	mg/L	2	20510 01-01	ND	NA	NA		NA	NA	20
B207045-DUP1	Dup	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Silver	ND	0.0200	0.0400	mg/L	2	20510 01-01	0.0220	NA	NA		NA	NA	20
B207045-DUP1	Dup	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Sodium	0.141	0.0200	0.0400	mg/L	2	20510 01-01	0.177	NA	NA	22.5	NA	NA	20
B207045-DUP1	Dup	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Thallium	ND	0.0200	0.0400	mg/L	2	20510 01-01	ND	NA	NA		NA	NA	20
B207045-DUP1	Dup	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Arsenic	ND	0.0200	0.0400	mg/L	2	20510 01-01	ND	NA	NA		NA	NA	20
B207045-DUP1	Dup	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Vanadium	ND	0.0200	0.0400	mg/L	2	20510 01-01	ND	NA	NA		NA	NA	20
B207045-DUP1	Dup	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Zinc	0.0442	0.0200	0.0400	mg/L	2	20510 01-01	0.0757	NA	NA	52.5	NA	NA	20
B207045-DUP1	Dup	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Barium	ND	0.0200	0.0400	mg/L	2	20510 01-01	ND	NA	NA		NA	NA	20
B207045-DUP1	Dup	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Beryllium	ND	0.0200	0.0400	mg/L	2	20510 01-01	ND	NA	NA		NA	NA	20
B207045-DUP1	Dup	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Cadmium	ND	0.0200	0.0400	mg/L	2	20510 01-01	0.0315	NA	NA		NA	NA	20
B207045-DUP1	Dup	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Calcium	0.265	0.0200	0.0400	mg/L	2	20510 01-01	0.278	NA	NA	4.78	NA	NA	20
B207045-DUP1	Dup	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Chromium	0.0896	0.0200	0.0400	mg/L	2	20510 01-01	0.0927	NA	NA	3.49	NA	NA	20
B207045-DUP2	Dup	Water	05/22/2012 00:00:00	05/25/2012 16:10:00	B207045	Aluminum	0.0535	0.0200	0.0400	mg/L	2	20525 01-01	0.0354	NA	NA	40.7	NA	NA	20
B207045-DUP2	Dup	Water	05/22/2012 00:00:00	05/25/2012 16:10:00	B207045	Cobalt	ND	0.0200	0.0400	mg/L	2	20525 01-01	ND	NA	NA		NA	NA	20
B207045-DUP2	Dup	Water	05/22/2012 00:00:00	05/25/2012 16:10:00	B207045	Copper	0.0451	0.0200	0.0400	mg/L	2	20525 01-01	0.0653	NA	NA	36.7	NA	NA	20

SAMPID	TYPE	MATRIX	PREPDATE	ANADATE	BATCH	ANALYTE	RESULT	DL	RL	UNITS	DIL	SORC ID	SORC RES	SPIKE LVL	REC	RPD	U CL	L CL	RPDCL
B207045-DUP2	Dup	Water	05/22/2012 00:00:00	05/25/2012 16:10:00	B207045	Iron	0.0995	0.0200	0.0400	mg/L	2	2052501-01	0.0801	NA	NA	21.6	NA	NA	20
B207045-DUP2	Dup	Water	05/22/2012 00:00:00	05/25/2012 16:10:00	B207045	Lead	0.0710	0.0200	0.0400	mg/L	2	2052501-01	0.196	NA	NA	93.8	NA	NA	20
B207045-DUP2	Dup	Water	05/22/2012 00:00:00	05/25/2012 16:10:00	B207045	Magnesium	0.192	0.0200	0.0400	mg/L	2	2052501-01	0.135	NA	NA	34.6	NA	NA	20
B207045-DUP2	Dup	Water	05/22/2012 00:00:00	05/25/2012 16:10:00	B207045	Manganese	ND	0.0200	0.0400	mg/L	2	2052501-01	ND	NA	NA		NA	NA	20
B207045-DUP2	Dup	Water	05/22/2012 00:00:00	05/25/2012 16:10:00	B207045	Nickel	ND	0.0200	0.0400	mg/L	2	2052501-01	ND	NA	NA		NA	NA	20
B207045-DUP2	Dup	Water	05/22/2012 00:00:00	05/25/2012 16:10:00	B207045	Phosphorus	0.0495	0.0200	0.0400	mg/L	2	2052501-01	0.0708	NA	NA	35.5	NA	NA	20
B207045-DUP2	Dup	Water	05/22/2012 00:00:00	05/25/2012 16:10:00	B207045	Potassium	0.516	0.0200	0.0400	mg/L	2	2052501-01	0.488	NA	NA	5.57	NA	NA	20
B207045-DUP2	Dup	Water	05/22/2012 00:00:00	05/25/2012 16:10:00	B207045	Antimony	0.0687	0.0200	0.0400	mg/L	2	2052501-01	0.152	NA	NA	75.5	NA	NA	20
B207045-DUP2	Dup	Water	05/22/2012 00:00:00	05/25/2012 16:10:00	B207045	Selenium	ND	0.0200	0.0400	mg/L	2	2052501-01	ND	NA	NA		NA	NA	20
B207045-DUP2	Dup	Water	05/22/2012 00:00:00	05/25/2012 16:10:00	B207045	Silver	ND	0.0200	0.0400	mg/L	2	2052501-01	0.0208	NA	NA		NA	NA	20
B207045-DUP2	Dup	Water	05/22/2012 00:00:00	05/25/2012 16:10:00	B207045	Sodium	0.478	0.0200	0.0400	mg/L	2	2052501-01	0.455	NA	NA	4.91	NA	NA	20
B207045-DUP2	Dup	Water	05/22/2012 00:00:00	05/25/2012 16:10:00	B207045	Thallium	ND	0.0200	0.0400	mg/L	2	2052501-01	ND	NA	NA		NA	NA	20
B207045-DUP2	Dup	Water	05/22/2012 00:00:00	05/25/2012 16:10:00	B207045	Arsenic	ND	0.0200	0.0400	mg/L	2	2052501-01	ND	NA	NA		NA	NA	20
B207045-DUP2	Dup	Water	05/22/2012 00:00:00	05/25/2012 16:10:00	B207045	Vanadium	ND	0.0200	0.0400	mg/L	2	2052501-01	ND	NA	NA		NA	NA	20
B207045-DUP2	Dup	Water	05/22/2012 00:00:00	05/25/2012 16:10:00	B207045	Zinc	0.0589	0.0200	0.0400	mg/L	2	2052501-01	0.0922	NA	NA	44.1	NA	NA	20
B207045-DUP2	Dup	Water	05/22/2012 00:00:00	05/25/2012 16:10:00	B207045	Barium	ND	0.0200	0.0400	mg/L	2	2052501-01	ND	NA	NA		NA	NA	20
B207045-DUP2	Dup	Water	05/22/2012 00:00:00	05/25/2012 16:10:00	B207045	Beryllium	ND	0.0200	0.0400	mg/L	2	2052501-01	ND	NA	NA		NA	NA	20
B207045-DUP2	Dup	Water	05/22/2012 00:00:00	05/25/2012 16:10:00	B207045	Cadmium	ND	0.0200	0.0400	mg/L	2	2052501-01	ND	NA	NA		NA	NA	20

SAMPID	TYPE	MATRIX	PREPDATE	ANADATE	BATCH	ANALYTE	RESULT	DL	RL	UNITS	DIL	SORC ID	SORC RES	SPIKE LVL	REC	RPD	U CL	L CL	RPDCL
B207045-DUP2	Dup	Water	05/22/2012 00:00:00	05/25/2012 16:10:00	B207045	Calcium	0.275	0.0200	0.0400	mg/L	2	20525 01-01	0.248	NA	NA	10.4	NA	NA	20
B207045-DUP2	Dup	Water	05/22/2012 00:00:00	05/25/2012 16:10:00	B207045	Chromium	ND	0.0200	0.0400	mg/L	2	20525 01-01	ND	NA	NA		NA	NA	20
B207045-MS1	Matrix Spike	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Aluminum	1.98	0.0200	0.0400	mg/L	2	20510 01-01	0.0552	2.000	96.4		120	80	NA
B207045-MS1	Matrix Spike	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Cobalt	2.00	0.0200	0.0400	mg/L	2	20510 01-01	ND	2.000	99.9		120	80	NA
B207045-MS1	Matrix Spike	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Copper	2.05	0.0200	0.0400	mg/L	2	20510 01-01	0.0488	2.000	100		120	80	NA
B207045-MS1	Matrix Spike	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Iron	2.40	0.0200	0.0400	mg/L	2	20510 01-01	0.333	2.000	103		120	80	NA
B207045-MS1	Matrix Spike	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Lead	1.97	0.0200	0.0400	mg/L	2	20510 01-01	0.0240	2.000	97.1		120	80	NA
B207045-MS1	Matrix Spike	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Magnesium	2.12	0.0200	0.0400	mg/L	2	20510 01-01	0.147	2.000	98.8		120	80	NA
B207045-MS1	Matrix Spike	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Manganese	2.06	0.0200	0.0400	mg/L	2	20510 01-01	0.0241	2.000	102		120	80	NA
B207045-MS1	Matrix Spike	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Nickel	2.12	0.0200	0.0400	mg/L	2	20510 01-01	0.109	2.000	100		120	80	NA
B207045-MS1	Matrix Spike	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Phosphorus	1.84	0.0200	0.0400	mg/L	2	20510 01-01	ND	2.000	91.8		120	80	NA
B207045-MS1	Matrix Spike	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Potassium	2.10	0.0200	0.0400	mg/L	2	20510 01-01	0.390	2.000	85.7		120	80	NA
B207045-MS1	Matrix Spike	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Antimony	1.85	0.0200	0.0400	mg/L	2	20510 01-01	0.0285	2.000	91.2		120	80	NA
B207045-MS1	Matrix Spike	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Selenium	1.82	0.0200	0.0400	mg/L	2	20510 01-01	ND	2.000	91.2		120	80	NA
B207045-MS1	Matrix Spike	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Silver	1.88	0.0200	0.0400	mg/L	2	20510 01-01	0.0220	2.000	93.0		120	80	NA
B207045-MS1	Matrix Spike	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Sodium	2.05	0.0200	0.0400	mg/L	2	20510 01-01	0.177	2.000	93.7		120	80	NA
B207045-MS1	Matrix Spike	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Thallium	1.96	0.0200	0.0400	mg/L	2	20510 01-01	ND	2.000	98.2		120	80	NA
B207045-MS1	Matrix Spike	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Arsenic	1.88	0.0200	0.0400	mg/L	2	20510 01-01	ND	2.000	94.2		120	80	NA

SAMPID	TYPE	MATRIX	PREPDATE	ANADATE	BATCH	ANALYTE	RESULT	DL	RL	UNITS	DIL	SORC ID	SORC RES	SPIKE LVL	REC	RPD	U CL	L CL	RPDCL
B207045-MS1	Matrix Spike	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Vanadium	1.95	0.0200	0.0400	mg/L	2	20510 01-01	ND	2.000	97.3		120	80	NA
B207045-MS1	Matrix Spike	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Zinc	1.95	0.0200	0.0400	mg/L	2	20510 01-01	0.0757	2.000	93.6		120	80	NA
B207045-MS1	Matrix Spike	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Barium	1.93	0.0200	0.0400	mg/L	2	20510 01-01	ND	2.000	96.6		120	80	NA
B207045-MS1	Matrix Spike	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Beryllium	1.95	0.0200	0.0400	mg/L	2	20510 01-01	ND	2.000	97.6		120	80	NA
B207045-MS1	Matrix Spike	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Cadmium	1.96	0.0200	0.0400	mg/L	2	20510 01-01	0.0315	2.000	96.4		120	80	NA
B207045-MS1	Matrix Spike	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Calcium	2.28	0.0200	0.0400	mg/L	2	20510 01-01	0.278	2.000	99.9		120	80	NA
B207045-MS1	Matrix Spike	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Chromium	2.13	0.0200	0.0400	mg/L	2	20510 01-01	0.0927	2.000	102		120	80	NA
B207045-MS2	Matrix Spike	Water	05/22/2012 00:00:00	05/25/2012 16:10:00	B207045	Aluminum	2.09	0.0200	0.0400	mg/L	2	20525 01-01	0.0354	2.000	103		120	80	NA
B207045-MS2	Matrix Spike	Water	05/22/2012 00:00:00	05/25/2012 16:10:00	B207045	Cobalt	2.06	0.0200	0.0400	mg/L	2	20525 01-01	ND	2.000	103		120	80	NA
B207045-MS2	Matrix Spike	Water	05/22/2012 00:00:00	05/25/2012 16:10:00	B207045	Copper	2.15	0.0200	0.0400	mg/L	2	20525 01-01	0.0653	2.000	104		120	80	NA
B207045-MS2	Matrix Spike	Water	05/22/2012 00:00:00	05/25/2012 16:10:00	B207045	Iron	2.23	0.0200	0.0400	mg/L	2	20525 01-01	0.0801	2.000	108		120	80	NA
B207045-MS2	Matrix Spike	Water	05/22/2012 00:00:00	05/25/2012 16:10:00	B207045	Lead	2.06	0.0200	0.0400	mg/L	2	20525 01-01	0.196	2.000	93.2		120	80	NA
B207045-MS2	Matrix Spike	Water	05/22/2012 00:00:00	05/25/2012 16:10:00	B207045	Magnesium	2.25	0.0200	0.0400	mg/L	2	20525 01-01	0.135	2.000	106		120	80	NA
B207045-MS2	Matrix Spike	Water	05/22/2012 00:00:00	05/25/2012 16:10:00	B207045	Manganese	2.06	0.0200	0.0400	mg/L	2	20525 01-01	ND	2.000	103		120	80	NA
B207045-MS2	Matrix Spike	Water	05/22/2012 00:00:00	05/25/2012 16:10:00	B207045	Nickel	2.07	0.0200	0.0400	mg/L	2	20525 01-01	ND	2.000	103		120	80	NA
B207045-MS2	Matrix Spike	Water	05/22/2012 00:00:00	05/25/2012 16:10:00	B207045	Phosphorus	1.94	0.0200	0.0400	mg/L	2	20525 01-01	0.0708	2.000	93.2		120	80	NA
B207045-MS2	Matrix Spike	Water	05/22/2012 00:00:00	05/25/2012 16:10:00	B207045	Potassium	2.43	0.0200	0.0400	mg/L	2	20525 01-01	0.488	2.000	96.9		120	80	NA
B207045-MS2	Matrix Spike	Water	05/22/2012 00:00:00	05/25/2012 16:10:00	B207045	Antimony	1.97	0.0200	0.0400	mg/L	2	20525 01-01	0.152	2.000	90.8		120	80	NA

SAMPID	TYPE	MATRIX	PREPDATE	ANADATE	BATCH	ANALYTE	RESULT	DL	RL	UNITS	DIL	SORC ID	SORC RES	SPIKE LVL	REC	RPD	U CL	L CL	RPDCL
B207045-MS2	Matrix Spike	Water	05/22/2012 00:00:00	05/25/2012 16:10:00	B207045	Selenium	1.92	0.0200	0.0400	mg/L	2	20525 01-01	ND	2.000	96.1		120	80	NA
B207045-MS2	Matrix Spike	Water	05/22/2012 00:00:00	05/25/2012 16:10:00	B207045	Silver	1.97	0.0200	0.0400	mg/L	2	20525 01-01	0.0208	2.000	97.6		120	80	NA
B207045-MS2	Matrix Spike	Water	05/22/2012 00:00:00	05/25/2012 16:10:00	B207045	Sodium	2.48	0.0200	0.0400	mg/L	2	20525 01-01	0.455	2.000	101		120	80	NA
B207045-MS2	Matrix Spike	Water	05/22/2012 00:00:00	05/25/2012 16:10:00	B207045	Thallium	2.05	0.0200	0.0400	mg/L	2	20525 01-01	ND	2.000	102		120	80	NA
B207045-MS2	Matrix Spike	Water	05/22/2012 00:00:00	05/25/2012 16:10:00	B207045	Arsenic	1.94	0.0200	0.0400	mg/L	2	20525 01-01	ND	2.000	97.2		120	80	NA
B207045-MS2	Matrix Spike	Water	05/22/2012 00:00:00	05/25/2012 16:10:00	B207045	Vanadium	2.01	0.0200	0.0400	mg/L	2	20525 01-01	ND	2.000	100		120	80	NA
B207045-MS2	Matrix Spike	Water	05/22/2012 00:00:00	05/25/2012 16:10:00	B207045	Zinc	2.02	0.0200	0.0400	mg/L	2	20525 01-01	0.0922	2.000	96.4		120	80	NA
B207045-MS2	Matrix Spike	Water	05/22/2012 00:00:00	05/25/2012 16:10:00	B207045	Barium	2.03	0.0200	0.0400	mg/L	2	20525 01-01	ND	2.000	101		120	80	NA
B207045-MS2	Matrix Spike	Water	05/22/2012 00:00:00	05/25/2012 16:10:00	B207045	Beryllium	2.07	0.0200	0.0400	mg/L	2	20525 01-01	ND	2.000	104		120	80	NA
B207045-MS2	Matrix Spike	Water	05/22/2012 00:00:00	05/25/2012 16:10:00	B207045	Cadmium	2.03	0.0200	0.0400	mg/L	2	20525 01-01	ND	2.000	102		120	80	NA
B207045-MS2	Matrix Spike	Water	05/22/2012 00:00:00	05/25/2012 16:10:00	B207045	Calcium	2.34	0.0200	0.0400	mg/L	2	20525 01-01	0.248	2.000	104		120	80	NA
B207045-MS2	Matrix Spike	Water	05/22/2012 00:00:00	05/25/2012 16:10:00	B207045	Chromium	2.10	0.0200	0.0400	mg/L	2	20525 01-01	ND	2.000	105		120	80	NA
B206013-BLK1	Blank	Soil/Sed	05/24/2012 16:42:00	05/25/2012 16:10:00	B206013	Aluminum	ND	2.00	4.00	mg/kg	2	NA	NA	NA	NA	NA	NA	NA	NA
B206013-BLK1	Blank	Soil/Sed	05/24/2012 16:42:00	05/25/2012 16:10:00	B206013	Copper	ND	2.00	4.00	mg/kg	2	NA	NA	NA	NA	NA	NA	NA	NA
B206013-BLK1	Blank	Soil/Sed	05/24/2012 16:42:00	05/25/2012 16:10:00	B206013	Iron	ND	2.00	4.00	mg/kg	2	NA	NA	NA	NA	NA	NA	NA	NA
B206013-BLK1	Blank	Soil/Sed	05/24/2012 16:42:00	05/25/2012 16:10:00	B206013	Lead	ND	2.00	4.00	mg/kg	2	NA	NA	NA	NA	NA	NA	NA	NA
B206013-BLK1	Blank	Soil/Sed	05/24/2012 16:42:00	05/25/2012 16:10:00	B206013	Magnesium	ND	2.00	4.00	mg/kg	2	NA	NA	NA	NA	NA	NA	NA	NA
B206013-BLK1	Blank	Soil/Sed	05/24/2012 16:42:00	05/25/2012 16:10:00	B206013	Manganese	ND	2.00	4.00	mg/kg	2	NA	NA	NA	NA	NA	NA	NA	NA

SAMPID	TYPE	MATRIX	PREPDATE	ANADATE	BATCH	ANALYTE	RESULT	DL	RL	UNITS	DIL	SORC ID	SORC RES	SPIKE LVL	REC	RPD	U CL	L CL	RPDCL
B206013-BLK1	Blank	Soil/Sed	05/24/2012 16:42:00	05/25/2012 16:10:00	B206013	Nickel	ND	2.00	4.00	mg/kg	2	NA	NA	NA	NA	NA	NA	NA	NA
B206013-BLK1	Blank	Soil/Sed	05/24/2012 16:42:00	05/25/2012 16:10:00	B206013	Phosphorus	ND	2.00	4.00	mg/kg	2	NA	NA	NA	NA	NA	NA	NA	NA
B206013-BLK1	Blank	Soil/Sed	05/24/2012 16:42:00	05/25/2012 16:10:00	B206013	Potassium	ND	2.00	4.00	mg/kg	2	NA	NA	NA	NA	NA	NA	NA	NA
B206013-BLK1	Blank	Soil/Sed	05/24/2012 16:42:00	05/25/2012 16:10:00	B206013	Selenium	ND	2.00	4.00	mg/kg	2	NA	NA	NA	NA	NA	NA	NA	NA
B206013-BLK1	Blank	Soil/Sed	05/24/2012 16:42:00	05/25/2012 16:10:00	B206013	Antimony	ND	2.00	4.00	mg/kg	2	NA	NA	NA	NA	NA	NA	NA	NA
B206013-BLK1	Blank	Soil/Sed	05/24/2012 16:42:00	05/25/2012 16:10:00	B206013	Silver	ND	2.00	4.00	mg/kg	2	NA	NA	NA	NA	NA	NA	NA	NA
B206013-BLK1	Blank	Soil/Sed	05/24/2012 16:42:00	05/25/2012 16:10:00	B206013	Sodium	ND	2.00	4.00	mg/kg	2	NA	NA	NA	NA	NA	NA	NA	NA
B206013-BLK1	Blank	Soil/Sed	05/24/2012 16:42:00	05/25/2012 16:10:00	B206013	Thallium	ND	2.00	4.00	mg/kg	2	NA	NA	NA	NA	NA	NA	NA	NA
B206013-BLK1	Blank	Soil/Sed	05/24/2012 16:42:00	05/25/2012 16:10:00	B206013	Vanadium	ND	2.00	4.00	mg/kg	2	NA	NA	NA	NA	NA	NA	NA	NA
B206013-BLK1	Blank	Soil/Sed	05/24/2012 16:42:00	05/25/2012 16:10:00	B206013	Zinc	ND	2.00	4.00	mg/kg	2	NA	NA	NA	NA	NA	NA	NA	NA
B206013-BLK1	Blank	Soil/Sed	05/24/2012 16:42:00	05/25/2012 16:10:00	B206013	Arsenic	ND	2.00	4.00	mg/kg	2	NA	NA	NA	NA	NA	NA	NA	NA
B206013-BLK1	Blank	Soil/Sed	05/24/2012 16:42:00	05/25/2012 16:10:00	B206013	Barium	ND	2.00	4.00	mg/kg	2	NA	NA	NA	NA	NA	NA	NA	NA
B206013-BLK1	Blank	Soil/Sed	05/24/2012 16:42:00	05/25/2012 16:10:00	B206013	Beryllium	ND	2.00	4.00	mg/kg	2	NA	NA	NA	NA	NA	NA	NA	NA
B206013-BLK1	Blank	Soil/Sed	05/24/2012 16:42:00	05/25/2012 16:10:00	B206013	Cadmium	ND	2.00	4.00	mg/kg	2	NA	NA	NA	NA	NA	NA	NA	NA
B206013-BLK1	Blank	Soil/Sed	05/24/2012 16:42:00	05/25/2012 16:10:00	B206013	Calcium	ND	2.00	4.00	mg/kg	2	NA	NA	NA	NA	NA	NA	NA	NA
B206013-BLK1	Blank	Soil/Sed	05/24/2012 16:42:00	05/25/2012 16:10:00	B206013	Chromium	ND	2.00	4.00	mg/kg	2	NA	NA	NA	NA	NA	NA	NA	NA
B206013-BLK1	Blank	Soil/Sed	05/24/2012 16:42:00	05/25/2012 16:10:00	B206013	Cobalt	ND	2.00	4.00	mg/kg	2	NA	NA	NA	NA	NA	NA	NA	NA
B206013-BS1	LCS	Soil/Sed	05/24/2012 16:42:00	05/25/2012 16:10:00	B206013	Aluminum	253	2.00	4.00	mg/kg	2	NA	NA	250.0	101	NA	120	80	NA

SAMPID	TYPE	MATRIX	PREPDATE	ANADATE	BATCH	ANALYTE	RESULT	DL	RL	UNITS	DIL	SORC ID	SORC RES	SPIKE LVL	REC	RPD	U CL	L CL	RPDCL
B206013-BS1	LCS	Soil/Sed	05/24/2012 16:42:00	05/25/2012 16:10:00	B206013	Copper	254	2.00	4.00	mg/kg	2	NA	NA	250.0	102	NA	120	80	NA
B206013-BS1	LCS	Soil/Sed	05/24/2012 16:42:00	05/25/2012 16:10:00	B206013	Iron	263	2.00	4.00	mg/kg	2	NA	NA	250.0	105	NA	120	80	NA
B206013-BS1	LCS	Soil/Sed	05/24/2012 16:42:00	05/25/2012 16:10:00	B206013	Lead	254	2.00	4.00	mg/kg	2	NA	NA	250.0	102	NA	120	80	NA
B206013-BS1	LCS	Soil/Sed	05/24/2012 16:42:00	05/25/2012 16:10:00	B206013	Magnesium	259	2.00	4.00	mg/kg	2	NA	NA	250.0	104	NA	120	80	NA
B206013-BS1	LCS	Soil/Sed	05/24/2012 16:42:00	05/25/2012 16:10:00	B206013	Manganese	252	2.00	4.00	mg/kg	2	NA	NA	250.0	101	NA	120	80	NA
B206013-BS1	LCS	Soil/Sed	05/24/2012 16:42:00	05/25/2012 16:10:00	B206013	Nickel	257	2.00	4.00	mg/kg	2	NA	NA	250.0	103	NA	120	80	NA
B206013-BS1	LCS	Soil/Sed	05/24/2012 16:42:00	05/25/2012 16:10:00	B206013	Phosphorus	244	2.00	4.00	mg/kg	2	NA	NA	250.0	97.6	NA	120	80	NA
B206013-BS1	LCS	Soil/Sed	05/24/2012 16:42:00	05/25/2012 16:10:00	B206013	Potassium	243	2.00	4.00	mg/kg	2	NA	NA	250.0	97.3	NA	120	80	NA
B206013-BS1	LCS	Soil/Sed	05/24/2012 16:42:00	05/25/2012 16:10:00	B206013	Selenium	245	2.00	4.00	mg/kg	2	NA	NA	250.0	97.9	NA	120	80	NA
B206013-BS1	LCS	Soil/Sed	05/24/2012 16:42:00	05/25/2012 16:10:00	B206013	Antimony	246	2.00	4.00	mg/kg	2	NA	NA	250.0	98.4	NA	120	80	NA
B206013-BS1	LCS	Soil/Sed	05/24/2012 16:42:00	05/25/2012 16:10:00	B206013	Silver	247	2.00	4.00	mg/kg	2	NA	NA	250.0	98.9	NA	120	80	NA
B206013-BS1	LCS	Soil/Sed	05/24/2012 16:42:00	05/25/2012 16:10:00	B206013	Sodium	252	2.00	4.00	mg/kg	2	NA	NA	250.0	101	NA	120	80	NA
B206013-BS1	LCS	Soil/Sed	05/24/2012 16:42:00	05/25/2012 16:10:00	B206013	Thallium	258	2.00	4.00	mg/kg	2	NA	NA	250.0	103	NA	120	80	NA
B206013-BS1	LCS	Soil/Sed	05/24/2012 16:42:00	05/25/2012 16:10:00	B206013	Vanadium	246	2.00	4.00	mg/kg	2	NA	NA	250.0	98.3	NA	120	80	NA
B206013-BS1	LCS	Soil/Sed	05/24/2012 16:42:00	05/25/2012 16:10:00	B206013	Zinc	260	2.00	4.00	mg/kg	2	NA	NA	250.0	104	NA	120	80	NA
B206013-BS1	LCS	Soil/Sed	05/24/2012 16:42:00	05/25/2012 16:10:00	B206013	Arsenic	244	2.00	4.00	mg/kg	2	NA	NA	250.0	97.7	NA	120	80	NA
B206013-BS1	LCS	Soil/Sed	05/24/2012 16:42:00	05/25/2012 16:10:00	B206013	Barium	247	2.00	4.00	mg/kg	2	NA	NA	250.0	98.7	NA	120	80	NA
B206013-BS1	LCS	Soil/Sed	05/24/2012 16:42:00	05/25/2012 16:10:00	B206013	Beryllium	253	2.00	4.00	mg/kg	2	NA	NA	250.0	101	NA	120	80	NA

SAMPID	TYPE	MATRIX	PREPDATE	ANADATE	BATCH	ANALYTE	RESULT	DL	RL	UNITS	DIL	SORC ID	SORC RES	SPIKE LVL	REC	RPD	U CL	L CL	RPDCL
B206013-BS1	LCS	Soil/Sed	05/24/2012 16:42:00	05/25/2012 16:10:00	B206013	Cadmium	203	2.00	4.00	mg/kg	2	NA	NA	250.0	81.0	NA	120	80	NA
B206013-BS1	LCS	Soil/Sed	05/24/2012 16:42:00	05/25/2012 16:10:00	B206013	Calcium	257	2.00	4.00	mg/kg	2	NA	NA	250.0	103	NA	120	80	NA
B206013-BS1	LCS	Soil/Sed	05/24/2012 16:42:00	05/25/2012 16:10:00	B206013	Chromium	255	2.00	4.00	mg/kg	2	NA	NA	250.0	102	NA	120	80	NA
B206013-BS1	LCS	Soil/Sed	05/24/2012 16:42:00	05/25/2012 16:10:00	B206013	Cobalt	254	2.00	4.00	mg/kg	2	NA	NA	250.0	102	NA	120	80	NA
B207045-BLK1	Blank	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Aluminum	ND	0.0200	0.0400	mg/L	2	NA	NA	NA	NA	NA	NA	NA	NA
B207045-BLK1	Blank	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Cobalt	ND	0.0200	0.0400	mg/L	2	NA	NA	NA	NA	NA	NA	NA	NA
B207045-BLK1	Blank	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Copper	ND	0.0200	0.0400	mg/L	2	NA	NA	NA	NA	NA	NA	NA	NA
B207045-BLK1	Blank	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Iron	ND	0.0200	0.0400	mg/L	2	NA	NA	NA	NA	NA	NA	NA	NA
B207045-BLK1	Blank	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Lead	ND	0.0200	0.0400	mg/L	2	NA	NA	NA	NA	NA	NA	NA	NA
B207045-BLK1	Blank	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Magnesium	ND	0.0200	0.0400	mg/L	2	NA	NA	NA	NA	NA	NA	NA	NA
B207045-BLK1	Blank	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Manganese	ND	0.0200	0.0400	mg/L	2	NA	NA	NA	NA	NA	NA	NA	NA
B207045-BLK1	Blank	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Nickel	ND	0.0200	0.0400	mg/L	2	NA	NA	NA	NA	NA	NA	NA	NA
B207045-BLK1	Blank	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Phosphorus	ND	0.0200	0.0400	mg/L	2	NA	NA	NA	NA	NA	NA	NA	NA
B207045-BLK1	Blank	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Potassium	ND	0.0200	0.0400	mg/L	2	NA	NA	NA	NA	NA	NA	NA	NA
B207045-BLK1	Blank	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Antimony	ND	0.0200	0.0400	mg/L	2	NA	NA	NA	NA	NA	NA	NA	NA
B207045-BLK1	Blank	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Selenium	ND	0.0200	0.0400	mg/L	2	NA	NA	NA	NA	NA	NA	NA	NA
B207045-BLK1	Blank	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Silver	ND	0.0200	0.0400	mg/L	2	NA	NA	NA	NA	NA	NA	NA	NA
B207045-BLK1	Blank	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Sodium	ND	0.0200	0.0400	mg/L	2	NA	NA	NA	NA	NA	NA	NA	NA

SAMPID	TYPE	MATRIX	PREPDATE	ANADATE	BATCH	ANALYTE	RESULT	DL	RL	UNITS	DIL	SORC ID	SORC RES	SPIKE LVL	REC	RPD	U CL	L CL	RPDCL
B207045-BLK1	Blank	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Thallium	ND	0.0200	0.0400	mg/L	2	NA	NA	NA	NA	NA	NA	NA	NA
B207045-BLK1	Blank	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Arsenic	ND	0.0200	0.0400	mg/L	2	NA	NA	NA	NA	NA	NA	NA	NA
B207045-BLK1	Blank	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Vanadium	ND	0.0200	0.0400	mg/L	2	NA	NA	NA	NA	NA	NA	NA	NA
B207045-BLK1	Blank	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Zinc	ND	0.0200	0.0400	mg/L	2	NA	NA	NA	NA	NA	NA	NA	NA
B207045-BLK1	Blank	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Barium	ND	0.0200	0.0400	mg/L	2	NA	NA	NA	NA	NA	NA	NA	NA
B207045-BLK1	Blank	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Beryllium	ND	0.0200	0.0400	mg/L	2	NA	NA	NA	NA	NA	NA	NA	NA
B207045-BLK1	Blank	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Cadmium	ND	0.0200	0.0400	mg/L	2	NA	NA	NA	NA	NA	NA	NA	NA
B207045-BLK1	Blank	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Calcium	ND	0.0200	0.0400	mg/L	2	NA	NA	NA	NA	NA	NA	NA	NA
B207045-BLK1	Blank	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Chromium	ND	0.0200	0.0400	mg/L	2	NA	NA	NA	NA	NA	NA	NA	NA
B207045-BS1	LCS	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Aluminum	2.45	0.0200	0.0400	mg/L	2	NA	NA	2.500	98.1	NA	120	80	NA
B207045-BS1	LCS	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Cobalt	2.50	0.0200	0.0400	mg/L	2	NA	NA	2.500	100	NA	120	80	NA
B207045-BS1	LCS	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Copper	2.52	0.0200	0.0400	mg/L	2	NA	NA	2.500	101	NA	120	80	NA
B207045-BS1	LCS	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Iron	2.58	0.0200	0.0400	mg/L	2	NA	NA	2.500	103	NA	120	80	NA
B207045-BS1	LCS	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Lead	2.52	0.0200	0.0400	mg/L	2	NA	NA	2.500	101	NA	120	80	NA
B207045-BS1	LCS	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Magnesium	2.51	0.0200	0.0400	mg/L	2	NA	NA	2.500	101	NA	120	80	NA
B207045-BS1	LCS	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Manganese	2.49	0.0200	0.0400	mg/L	2	NA	NA	2.500	99.6	NA	120	80	NA
B207045-BS1	LCS	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Nickel	2.55	0.0200	0.0400	mg/L	2	NA	NA	2.500	102	NA	120	80	NA
B207045-BS1	LCS	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Phosphorus	2.41	0.0200	0.0400	mg/L	2	NA	NA	2.500	96.6	NA	120	80	NA

SAMPID	TYPE	MATRIX	PREPDATE	ANADATE	BATCH	ANALYTE	RESULT	DL	RL	UNITS	DIL	SORC ID	SORC RES	SPIKE LVL	REC	RPD	U CL	L CL	RPDCL
B207045-BS1	LCS	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Potassium	2.37	0.0200	0.0400	mg/L	2	NA	NA	2.500	94.7	NA	120	80	NA
B207045-BS1	LCS	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Antimony	2.43	0.0200	0.0400	mg/L	2	NA	NA	2.500	97.1	NA	120	80	NA
B207045-BS1	LCS	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Selenium	2.43	0.0200	0.0400	mg/L	2	NA	NA	2.500	97.4	NA	120	80	NA
B207045-BS1	LCS	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Silver	2.44	0.0200	0.0400	mg/L	2	NA	NA	2.500	97.8	NA	120	80	NA
B207045-BS1	LCS	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Sodium	2.45	0.0200	0.0400	mg/L	2	NA	NA	2.500	97.8	NA	120	80	NA
B207045-BS1	LCS	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Thallium	2.53	0.0200	0.0400	mg/L	2	NA	NA	2.500	101	NA	120	80	NA
B207045-BS1	LCS	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Arsenic	2.43	0.0200	0.0400	mg/L	2	NA	NA	2.500	97.0	NA	120	80	NA
B207045-BS1	LCS	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Vanadium	2.43	0.0200	0.0400	mg/L	2	NA	NA	2.500	97.2	NA	120	80	NA
B207045-BS1	LCS	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Zinc	2.58	0.0200	0.0400	mg/L	2	NA	NA	2.500	103	NA	120	80	NA
B207045-BS1	LCS	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Barium	2.45	0.0200	0.0400	mg/L	2	NA	NA	2.500	97.9	NA	120	80	NA
B207045-BS1	LCS	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Beryllium	2.46	0.0200	0.0400	mg/L	2	NA	NA	2.500	98.3	NA	120	80	NA
B207045-BS1	LCS	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Cadmium	1.95	0.0200	0.0400	mg/L	2	NA	NA	2.500	77.8	NA	120	80	NA
B207045-BS1	LCS	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Calcium	2.52	0.0200	0.0400	mg/L	2	NA	NA	2.500	101	NA	120	80	NA
B207045-BS1	LCS	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Chromium	2.53	0.0200	0.0400	mg/L	2	NA	NA	2.500	101	NA	120	80	NA
B207045-DUP1	Dup	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Aluminum	0.0562	0.0200	0.0400	mg/L	2	20510 01-01	0.0552	NA	NA	1.79	NA	NA	20
B207045-DUP1	Dup	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Cobalt	ND	0.0200	0.0400	mg/L	2	20510 01-01	ND	NA	NA		NA	NA	20
B207045-DUP1	Dup	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Copper	0.0401	0.0200	0.0400	mg/L	2	20510 01-01	0.0488	NA	NA	19.8	NA	NA	20
B207045-DUP1	Dup	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Iron	0.333	0.0200	0.0400	mg/L	2	20510 01-01	0.333	NA	NA	0.0736	NA	NA	20

SAMPID	TYPE	MATRIX	PREPDATE	ANADATE	BATCH	ANALYTE	RESULT	DL	RL	UNITS	DIL	SORC ID	SORC RES	SPIKE LVL	REC	RPD	U CL	L CL	RPDCL
B207045-DUP1	Dup	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Lead	ND	0.0200	0.0400	mg/L	2	20510 01-01	0.0240	NA	NA		NA	NA	20
B207045-DUP1	Dup	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Magnesium	0.163	0.0200	0.0400	mg/L	2	20510 01-01	0.147	NA	NA	10.1	NA	NA	20
B207045-DUP1	Dup	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Manganese	0.0238	0.0200	0.0400	mg/L	2	20510 01-01	0.0241	NA	NA	1.31	NA	NA	20
B207045-DUP1	Dup	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Nickel	0.106	0.0200	0.0400	mg/L	2	20510 01-01	0.109	NA	NA	2.85	NA	NA	20
B207045-DUP1	Dup	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Phosphorus	ND	0.0200	0.0400	mg/L	2	20510 01-01	ND	NA	NA		NA	NA	20
B207045-DUP1	Dup	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Potassium	0.289	0.0200	0.0400	mg/L	2	20510 01-01	0.390	NA	NA	29.7	NA	NA	20
B207045-DUP1	Dup	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Antimony	ND	0.0200	0.0400	mg/L	2	20510 01-01	0.0285	NA	NA		NA	NA	20
B207045-DUP1	Dup	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Selenium	ND	0.0200	0.0400	mg/L	2	20510 01-01	ND	NA	NA		NA	NA	20
B207045-DUP1	Dup	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Silver	ND	0.0200	0.0400	mg/L	2	20510 01-01	0.0220	NA	NA		NA	NA	20
B207045-DUP1	Dup	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Sodium	0.141	0.0200	0.0400	mg/L	2	20510 01-01	0.177	NA	NA	22.5	NA	NA	20
B207045-DUP1	Dup	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Thallium	ND	0.0200	0.0400	mg/L	2	20510 01-01	ND	NA	NA		NA	NA	20
B207045-DUP1	Dup	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Arsenic	ND	0.0200	0.0400	mg/L	2	20510 01-01	ND	NA	NA		NA	NA	20
B207045-DUP1	Dup	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Vanadium	ND	0.0200	0.0400	mg/L	2	20510 01-01	ND	NA	NA		NA	NA	20
B207045-DUP1	Dup	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Zinc	0.0442	0.0200	0.0400	mg/L	2	20510 01-01	0.0757	NA	NA	52.5	NA	NA	20
B207045-DUP1	Dup	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Barium	ND	0.0200	0.0400	mg/L	2	20510 01-01	ND	NA	NA		NA	NA	20
B207045-DUP1	Dup	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Beryllium	ND	0.0200	0.0400	mg/L	2	20510 01-01	ND	NA	NA		NA	NA	20
B207045-DUP1	Dup	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Cadmium	ND	0.0200	0.0400	mg/L	2	20510 01-01	0.0315	NA	NA		NA	NA	20
B207045-DUP1	Dup	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Calcium	0.265	0.0200	0.0400	mg/L	2	20510 01-01	0.278	NA	NA	4.78	NA	NA	20

SAMPID	TYPE	MATRIX	PREPDATE	ANADATE	BATCH	ANALYTE	RESULT	DL	RL	UNITS	DIL	SORC ID	SORC RES	SPIKE LVL	REC	RPD	U CL	L CL	RPDCL
B207045-DUP1	Dup	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Chromium	0.0896	0.0200	0.0400	mg/L	2	20510 01-01	0.0927	NA	NA	3.49	NA	NA	20
B207045-DUP2	Dup	Water	05/22/2012 00:00:00	05/25/2012 16:10:00	B207045	Aluminum	0.0535	0.0200	0.0400	mg/L	2	20525 01-01	0.0354	NA	NA	40.7	NA	NA	20
B207045-DUP2	Dup	Water	05/22/2012 00:00:00	05/25/2012 16:10:00	B207045	Cobalt	ND	0.0200	0.0400	mg/L	2	20525 01-01	ND	NA	NA		NA	NA	20
B207045-DUP2	Dup	Water	05/22/2012 00:00:00	05/25/2012 16:10:00	B207045	Copper	0.0451	0.0200	0.0400	mg/L	2	20525 01-01	0.0653	NA	NA	36.7	NA	NA	20
B207045-DUP2	Dup	Water	05/22/2012 00:00:00	05/25/2012 16:10:00	B207045	Iron	0.0995	0.0200	0.0400	mg/L	2	20525 01-01	0.0801	NA	NA	21.6	NA	NA	20
B207045-DUP2	Dup	Water	05/22/2012 00:00:00	05/25/2012 16:10:00	B207045	Lead	0.0710	0.0200	0.0400	mg/L	2	20525 01-01	0.196	NA	NA	93.8	NA	NA	20
B207045-DUP2	Dup	Water	05/22/2012 00:00:00	05/25/2012 16:10:00	B207045	Magnesium	0.192	0.0200	0.0400	mg/L	2	20525 01-01	0.135	NA	NA	34.6	NA	NA	20
B207045-DUP2	Dup	Water	05/22/2012 00:00:00	05/25/2012 16:10:00	B207045	Manganese	ND	0.0200	0.0400	mg/L	2	20525 01-01	ND	NA	NA		NA	NA	20
B207045-DUP2	Dup	Water	05/22/2012 00:00:00	05/25/2012 16:10:00	B207045	Nickel	ND	0.0200	0.0400	mg/L	2	20525 01-01	ND	NA	NA		NA	NA	20
B207045-DUP2	Dup	Water	05/22/2012 00:00:00	05/25/2012 16:10:00	B207045	Phosphorus	0.0495	0.0200	0.0400	mg/L	2	20525 01-01	0.0708	NA	NA	35.5	NA	NA	20
B207045-DUP2	Dup	Water	05/22/2012 00:00:00	05/25/2012 16:10:00	B207045	Potassium	0.516	0.0200	0.0400	mg/L	2	20525 01-01	0.488	NA	NA	5.57	NA	NA	20
B207045-DUP2	Dup	Water	05/22/2012 00:00:00	05/25/2012 16:10:00	B207045	Antimony	0.0687	0.0200	0.0400	mg/L	2	20525 01-01	0.152	NA	NA	75.5	NA	NA	20
B207045-DUP2	Dup	Water	05/22/2012 00:00:00	05/25/2012 16:10:00	B207045	Selenium	ND	0.0200	0.0400	mg/L	2	20525 01-01	ND	NA	NA		NA	NA	20
B207045-DUP2	Dup	Water	05/22/2012 00:00:00	05/25/2012 16:10:00	B207045	Silver	ND	0.0200	0.0400	mg/L	2	20525 01-01	0.0208	NA	NA		NA	NA	20
B207045-DUP2	Dup	Water	05/22/2012 00:00:00	05/25/2012 16:10:00	B207045	Sodium	0.478	0.0200	0.0400	mg/L	2	20525 01-01	0.455	NA	NA	4.91	NA	NA	20
B207045-DUP2	Dup	Water	05/22/2012 00:00:00	05/25/2012 16:10:00	B207045	Thallium	ND	0.0200	0.0400	mg/L	2	20525 01-01	ND	NA	NA		NA	NA	20
B207045-DUP2	Dup	Water	05/22/2012 00:00:00	05/25/2012 16:10:00	B207045	Arsenic	ND	0.0200	0.0400	mg/L	2	20525 01-01	ND	NA	NA		NA	NA	20
B207045-DUP2	Dup	Water	05/22/2012 00:00:00	05/25/2012 16:10:00	B207045	Vanadium	ND	0.0200	0.0400	mg/L	2	20525 01-01	ND	NA	NA		NA	NA	20

SAMPID	TYPE	MATRIX	PREPDATE	ANADATE	BATCH	ANALYTE	RESULT	DL	RL	UNITS	DIL	SORC ID	SORC RES	SPIKE LVL	REC	RPD	U CL	L CL	RPDCL
B207045-DUP2	Dup	Water	05/22/2012 00:00:00	05/25/2012 16:10:00	B207045	Zinc	0.0589	0.0200	0.0400	mg/L	2	20525 01-01	0.0922	NA	NA	44.1	NA	NA	20
B207045-DUP2	Dup	Water	05/22/2012 00:00:00	05/25/2012 16:10:00	B207045	Barium	ND	0.0200	0.0400	mg/L	2	20525 01-01	ND	NA	NA		NA	NA	20
B207045-DUP2	Dup	Water	05/22/2012 00:00:00	05/25/2012 16:10:00	B207045	Beryllium	ND	0.0200	0.0400	mg/L	2	20525 01-01	ND	NA	NA		NA	NA	20
B207045-DUP2	Dup	Water	05/22/2012 00:00:00	05/25/2012 16:10:00	B207045	Cadmium	ND	0.0200	0.0400	mg/L	2	20525 01-01	ND	NA	NA		NA	NA	20
B207045-DUP2	Dup	Water	05/22/2012 00:00:00	05/25/2012 16:10:00	B207045	Calcium	0.275	0.0200	0.0400	mg/L	2	20525 01-01	0.248	NA	NA	10.4	NA	NA	20
B207045-DUP2	Dup	Water	05/22/2012 00:00:00	05/25/2012 16:10:00	B207045	Chromium	ND	0.0200	0.0400	mg/L	2	20525 01-01	ND	NA	NA		NA	NA	20
B207045-MS1	Matrix Spike	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Aluminum	1.98	0.0200	0.0400	mg/L	2	20510 01-01	0.0552	2.000	96.4	NA	120	80	NA
B207045-MS1	Matrix Spike	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Cobalt	2.00	0.0200	0.0400	mg/L	2	20510 01-01	ND	2.000	99.9	NA	120	80	NA
B207045-MS1	Matrix Spike	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Copper	2.05	0.0200	0.0400	mg/L	2	20510 01-01	0.0488	2.000	100	NA	120	80	NA
B207045-MS1	Matrix Spike	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Iron	2.40	0.0200	0.0400	mg/L	2	20510 01-01	0.333	2.000	103	NA	120	80	NA
B207045-MS1	Matrix Spike	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Lead	1.97	0.0200	0.0400	mg/L	2	20510 01-01	0.0240	2.000	97.1	NA	120	80	NA
B207045-MS1	Matrix Spike	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Magnesium	2.12	0.0200	0.0400	mg/L	2	20510 01-01	0.147	2.000	98.8	NA	120	80	NA
B207045-MS1	Matrix Spike	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Manganese	2.06	0.0200	0.0400	mg/L	2	20510 01-01	0.0241	2.000	102	NA	120	80	NA
B207045-MS1	Matrix Spike	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Nickel	2.12	0.0200	0.0400	mg/L	2	20510 01-01	0.109	2.000	100	NA	120	80	NA
B207045-MS1	Matrix Spike	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Phosphorus	1.84	0.0200	0.0400	mg/L	2	20510 01-01	ND	2.000	91.8	NA	120	80	NA
B207045-MS1	Matrix Spike	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Potassium	2.10	0.0200	0.0400	mg/L	2	20510 01-01	0.390	2.000	85.7	NA	120	80	NA
B207045-MS1	Matrix Spike	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Antimony	1.85	0.0200	0.0400	mg/L	2	20510 01-01	0.0285	2.000	91.2	NA	120	80	NA
B207045-MS1	Matrix Spike	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Selenium	1.82	0.0200	0.0400	mg/L	2	20510 01-01	ND	2.000	91.2	NA	120	80	NA

SAMPID	TYPE	MATRIX	PREPDATE	ANADATE	BATCH	ANALYTE	RESULT	DL	RL	UNITS	DIL	SORC ID	SORC RES	SPIKE LVL	REC	RPD	U CL	L CL	RPDCL
B207045-MS1	Matrix Spike	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Silver	1.88	0.0200	0.0400	mg/L	2	20510 01-01	0.0220	2.000	93.0	NA	120	80	NA
B207045-MS1	Matrix Spike	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Sodium	2.05	0.0200	0.0400	mg/L	2	20510 01-01	0.177	2.000	93.7	NA	120	80	NA
B207045-MS1	Matrix Spike	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Thallium	1.96	0.0200	0.0400	mg/L	2	20510 01-01	ND	2.000	98.2	NA	120	80	NA
B207045-MS1	Matrix Spike	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Arsenic	1.88	0.0200	0.0400	mg/L	2	20510 01-01	ND	2.000	94.2	NA	120	80	NA
B207045-MS1	Matrix Spike	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Vanadium	1.95	0.0200	0.0400	mg/L	2	20510 01-01	ND	2.000	97.3	NA	120	80	NA
B207045-MS1	Matrix Spike	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Zinc	1.95	0.0200	0.0400	mg/L	2	20510 01-01	0.0757	2.000	93.6	NA	120	80	NA
B207045-MS1	Matrix Spike	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Barium	1.93	0.0200	0.0400	mg/L	2	20510 01-01	ND	2.000	96.6	NA	120	80	NA
B207045-MS1	Matrix Spike	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Beryllium	1.95	0.0200	0.0400	mg/L	2	20510 01-01	ND	2.000	97.6	NA	120	80	NA
B207045-MS1	Matrix Spike	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Cadmium	1.96	0.0200	0.0400	mg/L	2	20510 01-01	0.0315	2.000	96.4	NA	120	80	NA
B207045-MS1	Matrix Spike	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Calcium	2.28	0.0200	0.0400	mg/L	2	20510 01-01	0.278	2.000	99.9	NA	120	80	NA
B207045-MS1	Matrix Spike	Water	05/11/2012 00:00:00	05/14/2012 14:37:00	B207045	Chromium	2.13	0.0200	0.0400	mg/L	2	20510 01-01	0.0927	2.000	102	NA	120	80	NA
B207045-MS2	Matrix Spike	Water	05/22/2012 00:00:00	05/25/2012 16:10:00	B207045	Aluminum	2.09	0.0200	0.0400	mg/L	2	20525 01-01	0.0354	2.000	103	NA	120	80	NA
B207045-MS2	Matrix Spike	Water	05/22/2012 00:00:00	05/25/2012 16:10:00	B207045	Cobalt	2.06	0.0200	0.0400	mg/L	2	20525 01-01	ND	2.000	103	NA	120	80	NA
B207045-MS2	Matrix Spike	Water	05/22/2012 00:00:00	05/25/2012 16:10:00	B207045	Copper	2.15	0.0200	0.0400	mg/L	2	20525 01-01	0.0653	2.000	104	NA	120	80	NA
B207045-MS2	Matrix Spike	Water	05/22/2012 00:00:00	05/25/2012 16:10:00	B207045	Iron	2.23	0.0200	0.0400	mg/L	2	20525 01-01	0.0801	2.000	108	NA	120	80	NA
B207045-MS2	Matrix Spike	Water	05/22/2012 00:00:00	05/25/2012 16:10:00	B207045	Lead	2.06	0.0200	0.0400	mg/L	2	20525 01-01	0.196	2.000	93.2	NA	120	80	NA
B207045-MS2	Matrix Spike	Water	05/22/2012 00:00:00	05/25/2012 16:10:00	B207045	Magnesium	2.25	0.0200	0.0400	mg/L	2	20525 01-01	0.135	2.000	106	NA	120	80	NA
B207045-MS2	Matrix Spike	Water	05/22/2012 00:00:00	05/25/2012 16:10:00	B207045	Manganese	2.06	0.0200	0.0400	mg/L	2	20525 01-01	ND	2.000	103	NA	120	80	NA

SAMPID	TYPE	MATRIX	PREPDATE	ANADATE	BATCH	ANALYTE	RESULT	DL	RL	UNITS	DIL	SORC ID	SORC RES	SPIKE LVL	REC	RPD	U CL	L CL	RPDCL
B207045-MS2	Matrix Spike	Water	05/22/2012 00:00:00	05/25/2012 16:10:00	B207045	Nickel	2.07	0.0200	0.0400	mg/L	2	2052501-01	ND	2.000	103	NA	120	80	NA
B207045-MS2	Matrix Spike	Water	05/22/2012 00:00:00	05/25/2012 16:10:00	B207045	Phosphorus	1.94	0.0200	0.0400	mg/L	2	2052501-01	0.0708	2.000	93.2	NA	120	80	NA
B207045-MS2	Matrix Spike	Water	05/22/2012 00:00:00	05/25/2012 16:10:00	B207045	Potassium	2.43	0.0200	0.0400	mg/L	2	2052501-01	0.488	2.000	96.9	NA	120	80	NA
B207045-MS2	Matrix Spike	Water	05/22/2012 00:00:00	05/25/2012 16:10:00	B207045	Antimony	1.97	0.0200	0.0400	mg/L	2	2052501-01	0.152	2.000	90.8	NA	120	80	NA
B207045-MS2	Matrix Spike	Water	05/22/2012 00:00:00	05/25/2012 16:10:00	B207045	Selenium	1.92	0.0200	0.0400	mg/L	2	2052501-01	ND	2.000	96.1	NA	120	80	NA
B207045-MS2	Matrix Spike	Water	05/22/2012 00:00:00	05/25/2012 16:10:00	B207045	Silver	1.97	0.0200	0.0400	mg/L	2	2052501-01	0.0208	2.000	97.6	NA	120	80	NA
B207045-MS2	Matrix Spike	Water	05/22/2012 00:00:00	05/25/2012 16:10:00	B207045	Sodium	2.48	0.0200	0.0400	mg/L	2	2052501-01	0.455	2.000	101	NA	120	80	NA
B207045-MS2	Matrix Spike	Water	05/22/2012 00:00:00	05/25/2012 16:10:00	B207045	Thallium	2.05	0.0200	0.0400	mg/L	2	2052501-01	ND	2.000	102	NA	120	80	NA
B207045-MS2	Matrix Spike	Water	05/22/2012 00:00:00	05/25/2012 16:10:00	B207045	Arsenic	1.94	0.0200	0.0400	mg/L	2	2052501-01	ND	2.000	97.2	NA	120	80	NA
B207045-MS2	Matrix Spike	Water	05/22/2012 00:00:00	05/25/2012 16:10:00	B207045	Vanadium	2.01	0.0200	0.0400	mg/L	2	2052501-01	ND	2.000	100	NA	120	80	NA
B207045-MS2	Matrix Spike	Water	05/22/2012 00:00:00	05/25/2012 16:10:00	B207045	Zinc	2.02	0.0200	0.0400	mg/L	2	2052501-01	0.0922	2.000	96.4	NA	120	80	NA
B207045-MS2	Matrix Spike	Water	05/22/2012 00:00:00	05/25/2012 16:10:00	B207045	Barium	2.03	0.0200	0.0400	mg/L	2	2052501-01	ND	2.000	101	NA	120	80	NA
B207045-MS2	Matrix Spike	Water	05/22/2012 00:00:00	05/25/2012 16:10:00	B207045	Beryllium	2.07	0.0200	0.0400	mg/L	2	2052501-01	ND	2.000	104	NA	120	80	NA
B207045-MS2	Matrix Spike	Water	05/22/2012 00:00:00	05/25/2012 16:10:00	B207045	Cadmium	2.03	0.0200	0.0400	mg/L	2	2052501-01	ND	2.000	102	NA	120	80	NA
B207045-MS2	Matrix Spike	Water	05/22/2012 00:00:00	05/25/2012 16:10:00	B207045	Calcium	2.34	0.0200	0.0400	mg/L	2	2052501-01	0.248	2.000	104	NA	120	80	NA
B207045-MS2	Matrix Spike	Water	05/22/2012 00:00:00	05/25/2012 16:10:00	B207045	Chromium	2.10	0.0200	0.0400	mg/L	2	2052501-01	ND	2.000	105	NA	120	80	NA

Appendix C: Results for Kimama Training Site

Field Sample ID	Number of Field Increments	Sample Date	Grid Location	Wet Mass (g)	Total Dry Mass (g)	< 2mm Mass (g)	> 2mm Mass (g)	Field Replicate	Analysis Date	Ag (mg/kg)	Al (mg/kg)	As (mg/kg)	Ba (mg/kg)	Be (mg/kg)	Ca (mg/kg)	Cd (mg/kg)	Co (mg/kg)	Cr (mg/kg)	Cu (mg/kg)	Fe (mg/kg)	K (mg/kg)
KTS 01	1	10/18/2011	1	88.9	NA	NA	NA	NA	14-Dec-11	<2.00	7740	3.31	82.1	<2.00	2270	<2.00	5.03	18.1	19.6	11000	2030
KTS 02	1	10/18/2011	2	80.6	NA	NA	NA	NA	14-Dec-11	<2.00	6410	3.51	64.2	<2.00	1800	<2.00	4.34	15.1	56.6	9880	1750
KTS 03	1	10/18/2011	3	81.8	NA	NA	NA	NA	14-Dec-11	<2.00	6440	7.8	72.9	<2.00	2100	<2.00	4.34	15.4	74.2	9650	1630
KTS 04	1	10/18/2011	4	78.1	NA	NA	NA	NA	14-Dec-11	<2.00	6950	3.41	73.5	<2.00	1860	<2.00	4.66	16	32.1	10000	1870
KTS 05	1	10/18/2011	5	123.1	NA	NA	NA	NA	14-Dec-11	<2.00	7480	3.21	80.8	<2.00	2580	<2.00	4.84	16.9	40.5	10400	2010
KTS 06	1	10/18/2011	6	89.8	NA	NA	NA	NA	14-Dec-11	<2.00	7430	3.08	74.7	<2.00	1830	<2.00	4.92	16.9	41.9	10900	1810
KTS 07	1	10/18/2011	7	85.3	NA	NA	NA	NA	14-Dec-11	<2.00	6590	3.4	66.1	<2.00	1480	<2.00	4.64	15.8	26	10100	1610
KTS 08	1	10/18/2011	8	101.0	NA	NA	NA	NA	14-Dec-11	<2.00	6210	3.09	61.6	<2.00	1530	<2.00	4.28	15.2	14.6	9620	1560
KTS 09	1	10/18/2011	9	66.5	NA	NA	NA	NA	14-Dec-11	<2.00	7820	4.08	73.4	<2.00	1750	<2.00	5.02	17.6	18	10900	1930
KTS 10	1	10/18/2011	10	87.8	NA	NA	NA	NA	20-Dec-11	<2.00	6630	3.22	62.2	<2.00	1520	<2.00	4.44	16.4	18.1	9980	1580
KTS 11	1	10/18/2011	11	90.1	NA	NA	NA	NA	20-Dec-11	<2.00	8150	3.41	80.9	<2.00	2010	<2.00	5.09	18.5	14.1	11600	2010
KTS 12	1	10/18/2011	12	80.5	NA	NA	NA	NA	14-Dec-11	<2.00	6720	3.07	89.2	<2.00	2520	<2.00	4.71	15.7	24	10300	1850
KTS 13	1	10/18/2011	13	85.3	NA	NA	NA	NA	20-Dec-11	<2.00	7090	3.26	66.9	<2.00	1760	<2.00	4.39	15.2	21.1	9660	1860
KTS 14	1	10/18/2011	14	120.6	NA	NA	NA	NA	14-Dec-11	<2.00	7630	3.65	75.6	<2.00	1960	<2.00	4.95	17.1	19.2	10600	1890
KTS 15	1	10/18/2011	15	97.4	NA	NA	NA	NA	20-Dec-11	<2.00	5920	2.97	61.1	<2.00	1690	<2.00	3.83	13.1	38.6	8390	1480
KTS 16	1	10/18/2011	16	108.0	NA	NA	NA	NA	14-Dec-11	<2.00	7430	3.08	74.7	<2.00	1830	<2.00	4.92	16.9	41.9	10900	1810
KTS 17	1	10/18/2011	17	105.0	NA	NA	NA	NA	14-Dec-11	<2.00	3030	<2.00	30.3	<2.00	892	<2.00	2.16	7.81	13.5	4690	799
KTS 18	1	10/18/2011	18	96.0	NA	NA	NA	NA	14-Dec-11	<2.00	6760	4.25	63.3	<2.00	1560	<2.00	4.76	16.4	15.6	10100	1660
KTS 19	1	10/18/2011	19	97.2	NA	NA	NA	NA	14-Dec-11	<2.00	6960	3.38	68.8	<2.00	1700	<2.00	4.46	15.8	13.1	9690	1830
KTS 20	1	10/18/2011	20	116.5	NA	NA	NA	NA	14-Dec-11	<2.00	5960	2.66	56.6	<2.00	1420	<2.00	4.12	14	13.4	8750	1540
KTS 21	1	10/18/2011	21	83.3	NA	NA	NA	NA	14-Dec-11	<2.00	7160	3.33	67	<2.00	1590	<2.00	4.68	16.3	9.83	10200	1890
KTS 22	1	10/18/2011	22	113.0	NA	NA	NA	NA	20-Dec-11	<2.00	6180	3.11	61	<2.00	1470	<2.00	4.2	15.4	10.2	9930	1600
KTS 23	1	10/18/2011	23	107.4	NA	NA	NA	NA	20-Dec-11	<2.00	7340	2.74	68.7	<2.00	1590	<2.00	4.52	16.1	11.7	9810	1920
KTS 24	1	10/18/2011	24	128.8	NA	NA	NA	NA	14-Dec-11	<2.00	6870	4.1	70.1	<2.00	1960	<2.00	4.44	15.6	13.9	9870	1720
KTS 25	1	10/18/2011	25	113.7	NA	NA	NA	NA	20-Dec-11	<2.00	7310	3.08	72.8	<2.00	2030	<2.00	4.39	15.6	14.2	10100	2120
KTS 26	1	10/18/2011	26	110.7	NA	NA	NA	NA	14-Dec-11	<2.00	7350	4.81	69.9	<2.00	2050	<2.00	4.73	16.6	21.7	10400	1860
KTS 27	1	10/18/2011	27	116.8	NA	NA	NA	NA	14-Dec-11	<2.00	7150	3.58	72.7	<2.00	1750	<2.00	4.89	17	12.5	10700	1860
KTS 28	1	10/18/2011	28	101.5	NA	NA	NA	NA	20-Dec-11	<2.00	6910	3.28	73.6	<2.00	1790	<2.00	4.58	16.4	18.2	10100	1840
KTS 29	1	10/18/2011	29	135.0	NA	NA	NA	NA	20-Dec-11	<2.00	6400	2.62	59.6	<2.00	1500	<2.00	4.08	14.4	10.8	9080	1730
KTS 30	1	10/18/2011	30	109.0	NA	NA	NA	NA	20-Dec-11	<2.00	7040	3.37	66.2	<2.00	1490	<2.00	4.51	15.8	12.1	9870	1980
KTS 31	106	10/18/2011	Entire Berm	964.1	890.7	869.5	19.8	REP 1	14-Dec-11	<2.00	4680	<2.00	54.1	<2.00	1230	<2.00	2.95	120	22.8	6580	1280
KTS 32	90	10/18/2011	Entire Berm	956.5	890.4	859.0	29.3	REP 2	14-Dec-11	<2.00	4790	<2.00	54	<2.00	1230	<2.00	2.95	105	50.8	6570	1330
KTS 33	102	10/18/2011	Entire Berm	1088.5	1010.9	979.5	28.5	REP 3	14-Dec-11	<2.00	4620	2.06	54.3	<2.00	1250	<2.00	2.98	139	13	6710	1290
KTS 34	90	10/18/2011	Entire Berm	840.7	779.4	760.2	16.3	REP 4	14-Dec-11												
KTS 35	90	10/18/2011	Entire Berm	848.9	789.6	772.4	15.5	REP 5	14-Dec-11	<2.00	4810	<2.00	55.5	<2.00	1260	<2.00	2.97	126	49.3	6710	1360
KTS 36	90	10/18/2011	Entire Berm	819.4	755.7	739.0	16.1	REP 6	14-Dec-11	<2.00	4760	<2.00	55.3	<2.00	1250	<2.00	2.95	134	13.6	6730	1320
KTS 37	96	10/19/2011	Entire Berm	801.2	743.1	726.2	15.8	REP 7	14-Dec-11	<2.00	4690	<2.00	54.8	<2.00	1250	<2.00	2.96	137	27.8	6750	1300
KTS 38	96	10/19/2011	Entire Berm	821.2	761.0	748.3	10.5	REP 8	14-Dec-11	<2.00	4720	<2.00	56.4	<2.00	1280	<2.00	3	156	17.6	6900	1360
KTS 39	96	10/19/2011	Entire Berm	823.2	763.0	748.3	13.2	REP 9	14-Dec-11	<2.00	4920	<2.00	57	<2.00	1300	<2.00	3.09	160	21.8	6980	1440
KTS 40	92	10/19/2011	Entire Berm	879.9	819.3	798.4	19.1	REP 10	14-Dec-11	<2.00	4640	2.02	54.3	<2.00	1220	<2.00	2.95	131	56.7	6620	1330
KTS 41	92	10/19/2011	Entire Berm	905.5	844.8	828.3	14.2	REP 11	14-Dec-11	<2.00	4580	<2.00	53.8	<2.00	1200	<2.00	2.89	120	65.5	6650	1240
KTS 42	92	10/19/2011	Entire Berm	847.3	789.7	775.3	12.7	REP 12	14-Dec-11	<2.00	4580	<2.00	53.5	<2.00	1230	<2.00	2.93	130	16.7	6630	1260
KTS 43	92	10/19/2011	Entire Berm	860.9	803.6	792.0	9.2	REP 13	14-Dec-11	<2.00	4980	<2.00	58.7	<2.00	1310	<2.00	3.11	172	53	7040	1460

Field Sample ID	Number of Field Increments	Sample Date	Grid Location	Wet Mass (g)	Total Dry Mass (g)	< 2mm Mass (g)	> 2mm Mass (g)	Field Replicate	Analysis Date	Ag (mg/kg)	Al (mg/kg)	As (mg/kg)	Ba (mg/kg)	Be (mg/kg)	Ca (mg/kg)	Cd (mg/kg)	Co (mg/kg)	Cr (mg/kg)	Cu (mg/kg)	Fe (mg/kg)	K (mg/kg)
KTS 44	92	10/19/2011	Entire Berm	874.2	814.9	804.6	8.9	REP 14	14-Dec-11	<2.00	4650	<2.00	53.3	<2.00	1210	<2.00	2.89	122	54.3	6570	1320
KTS 45	92	10/19/2011	Entire Berm	889.3	836.6	816.7	17.4	REP 15	24-May-12	0.368	9290	2.83	106	0.279	2380	1.41	5.57	215	30.6	12900	2570
KTS 46	86	10/19/2011	Entire Berm	1480.1	1363.9	1326.4	32.2	REP 1 BCKGD	14-Dec-11	<2.00	3960	<2.00	52	<2.00	1290	<2.00	2.65	123	5.71	6430	1000
KTS 47	86	10/19/2011	Entire Berm	1659.3	1525.9	1502.2	21.1	REP 2 BCKGD	14-Dec-11	<2.00	4180	<2.00	52.8	<2.00	1300	<2.00	2.74	112	5.67	6500	1100
KTS 48	86	10/19/2011	Entire Berm	1778.1	1645.4	1619.6	22.6	REP 3 BCKGD	24-May-12	0.301	7860	2.99	98	0.232	2370	1.34	4.87	159	12.5	12000	1980

Field Sample ID	Mg (mg/kg)	Mn (mg/kg)	Na (mg/kg)	Ni (mg/kg)	P (mg/kg)	Pb (mg/kg)	Sb (mg/kg)	Se (mg/kg)	Silica (mg/kg)	S (mg/kg)	Th (mg/kg)	V (mg/kg)	Zn (mg/kg)
KTS 01	2530	215	88.9	11.9	644	75.2	<2.00	<2.00	184	143	<2.00	20.8	52.5
KTS 02	2150	195	61.9	10.6	631	1240	2.16	<2.00	87.2	114	<2.00	16.9	53.2
KTS 03	2190	207	60.9	10.6	680	9060	70.2	<2.00	102	159	<2.00	16.7	56.2
KTS 04	2230	198	61.3	10.9	586	1050	3.32	<2.00	115	123	<2.00	17.8	45.9
KTS 05	2510	206	74.7	11.8	727	523	<2.00	<2.00	235	195	<2.00	19.2	54.8
KTS 06	2430	219	66	11.2	577	278	<2.00	<2.00	156	95.5	<2.00	19.6	51.3
KTS 07	2180	200	57	10.9	497	103	<2.00	<2.00	174	52.2	<2.00	17.9	47.5
KTS 08	2140	194	58.7	10.3	528	60.1	<2.00	<2.00	218	71.3	<2.00	17.5	41
KTS 09	2500	215	77.1	12.2	520	85	<2.00	2.21	179	75.8	<2.00	20.7	47.1
KTS 10	2100	179	66.8	10.7	463	44.5	<2.00	<2.00	228	48.9	<2.00	19.7	40.9
KTS 11	2460	234	73.8	11.7	600	39.2	<2.00	<2.00	138	82.1	<2.00	20.5	53.8
KTS 12	2270	278	59.3	10.9	726	287	<2.00	<2.00	105	163	<2.00	17	51.5
KTS 13	2060	194	63.7	10	506	96.5	<2.00	<2.00	103	69.3	<2.00	18	44.8
KTS 14	2290	214	75.6	11	564	325	<2.00	<2.00	163	99.9	<2.00	19.2	49.5
KTS 15	1870	163	55.5	8.71	469	556	<2.00	<2.00	117	81.2	<2.00	14.7	41.8
KTS 16	2430	219	66	11.2	577	278	<2.00	<2.00	156	95.5	<2.00	19.6	51.3
KTS 17	1030	93.9	28.7	5.15	243	71.8	<2.00	<2.00	85.3	52.1	<2.00	8.35	21.8
KTS 18	2270	192	72.3	11.3	455	31.4	<2.00	<2.00	133	60	<2.00	18.7	42.7
KTS 19	2180	188	72.6	10.7	509	24	<2.00	<2.00	194	81.5	<2.00	18.5	40.4
KTS 20	1890	167	60.7	9.52	457	14.1	<2.00	<2.00	196	55.2	<2.00	16.9	38.7
KTS 21	2150	197	68.8	10.1	544	11.1	<2.00	<2.00	216	78.1	<2.00	18.8	45
KTS 22	2000	187	57.9	9.71	506	19.2	<2.00	<2.00	136	49.6	<2.00	17.7	43.9
KTS 23	2160	195	62.8	10.5	525	29.9	<2.00	<2.00	193	69.6	<2.00	17.3	41.8
KTS 24	2140	199	82	10.6	594	39.7	2.71	<2.00	191	102	<2.00	18	46.1
KTS 25	2200	200	67.6	10.4	602	142	<2.00	<2.00	228	138	<2.00	17.6	44.3
KTS 26	2250	208	76.4	11.1	585	198	<2.00	<2.00	193	156	<2.00	18.9	50.9
KTS 27	2300	210	76.6	11.1	525	28.1	<2.00	<2.00	236	64.1	<2.00	19.3	44.3
KTS 28	2320	197	62.6	11	492	49.3	<2.00	<2.00	129	79.8	<2.00	18.3	42.1
KTS 29	2010	177	57.2	9.65	441	24.6	<2.00	<2.00	224	58.6	<2.00	16.7	36.6
KTS 30	2120	187	62.3	10.6	474	12.9	<2.00	<2.00	194	47.9	<2.00	18.7	39.8
KTS 31	1340	120	131	7.33	326	268	<2.00	<2.00	121	66.1	<2.00	13.2	26.6
KTS 32	1350	119	121	7.33	329	247	<2.00	<2.00	81.1	64.8	<2.00	13.5	29.9
KTS 33	1340	122	140	7.73	329	318	<2.00	<2.00	119	69.2	<2.00	13	26.1
KTS 34													
KTS 35	1350	120	135	7.5	332	318	<2.00	<2.00	94.2	67	<2.00	13.3	30.3
KTS 36	1340	121	137	7.42	328	234	<2.00	<2.00	120	67.6	<2.00	13.2	25.7
KTS 37	1350	121	135	7.56	332	290	<2.00	<2.00	98.2	68.1	<2.00	13.1	27.9
KTS 38	1340	123	147	7.82	334	284	<2.00	<2.00	132	72.2	<2.00	13	26.3
KTS 39	1380	124	155	7.9	330	220	<2.00	<2.00	92.9	70.7	<2.00	13.9	27.5
KTS 40	1310	117	131	7.48	325	350	<2.00	<2.00	90	63.9	<2.00	13.2	30.5
KTS 41	1310	117	125	7.4	326	296	<2.00	<2.00	126	62.8	<2.00	12.6	31.2
KTS 42	1330	119	132	7.48	328	276	<2.00	<2.00	84.1	71.7	<2.00	12.7	26
KTS 43	1370	125	167	8.02	327	294	<2.00	<2.00	143	67.8	<2.00	14.1	29.6

Field Sample ID	Mg (mg/kg)	Mn (mg/kg)	Na (mg/kg)	Ni (mg/kg)	P (mg/kg)	Pb (mg/kg)	Sb (mg/kg)	Se (mg/kg)	Silica (mg/kg)	S (mg/kg)	Th (mg/kg)	V (mg/kg)	Zn (mg/kg)
KTS 44	1320	118	130	7.34	323	268	<2.00	<2.00	130	64.3	<2.00	13	29.6
KTS 45	2690	236	254	14.2	599	428	<0.0200	3.9	NA	NA	0.0251	24.3	53.1
KTS 46	1240	111	121	6.8	325	5.17	<2.00	<2.00	79.2	91.8	<2.00	12.4	25.8
KTS 47	1270	112	121	6.79	315	5.57	<2.00	<2.00	109	79.3	<2.00	13.3	25.6
KTS 48	2450	211	211	12.4	566	12.1	<0.0200	3.7	NA	NA	<0.0200	23	49.9

Appendix D: Results for Fort Eustis

Field Sample ID	Number of Field Increments	Sample Date	Grid Location	Wet Mass (g)	Total Dry Mass (g)	< 2mm Mass (g)	> 2mm Mass (g)	Field Replicate	Analysis Date	Ag (mg/kg)	Al (mg/kg)	As (mg/kg)	Ba (mg/kg)	Be (mg/kg)	Ca (mg/kg)	Cd (mg/kg)	Co (mg/kg)	Cr (mg/kg)	Cu (mg/kg)	Fe (mg/kg)	K (mg/kg)
MI-1	99	12/13/2011	entire berm	1152.9	885.0	869.2	15.8	1	16-May-12	<0.0200	9740	1.85	57.3	0.282	1860	0.969	4.21	321	39.5	10600	942
MI-2	99	12/13/2011	entire berm	1078.5	823.8	799.8	24.0	2	16-May-12	<0.0200	9880	2.08	58.3	0.296	1910	0.971	4.47	381	69.2	11000	964
MI-3	99	12/13/2011	entire berm	1105.8	834.6	821.1	13.5	3	16-May-12	<0.0200	9820	2.17	57.7	0.286	1910	0.963	4.36	362	44.9	10700	956
MI-4	50	12/13/2011	Rt side of berm	473.3	343.9	337.5	6.4	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
MI-5	50	12/13/2011	Rt side of berm	508.2	372.5	359.8	12.7	2	16-May-12	0.747	9020	2.39	56	0.247	2610	0.99	4.21	460	207	10900	948
MI-6	50	12/13/2011	Rt side of berm	485.7	353.6	339.8	13.8	3	16-May-12	0.394	9090	2.42	54.4	0.235	2520	0.973	4.08	439	111	10800	962
MI-7	48	12/13/2011	Rt side of berm	518.5	405.9	392.6	13.3	4	16-May-12	0.204	9320	2.43	57.9	0.268	2280	0.959	4.08	410	194	10800	952
MI-8	48	12/13/2011	Rt side of berm	504.1	395.2	387.0	8.2	5	16-May-12	0.0543	8530	2.26	55.9	0.274	2210	0.884	3.82	422	108	10600	845
MI-9	48	12/13/2011	Rt side of berm	573.6	449.5	440.6	8.9	6	16-May-12	0.0927	9130	2.04	55.9	0.264	2110	0.922	3.74	347	70.4	10200	905
MI-10	48	12/13/2011	Rt side of berm	494.7	376.1	363.6	12.5	7	16-May-12	0.0345	8970	2.36	53.4	0.247	2230	0.95	4.07	430	105	10900	926
MI-11	48	12/13/2011	Rt side of berm	483.0	362.3	354.3	8.0	8	16-May-12	<0.0200	8780	2.3	52.2	0.222	2340	0.922	3.93	424	53.9	10700	916
MI-12	48	12/13/2011	Rt side of berm	462.1	347.2	324.0	23.2	9	16-May-12	<0.0200	8850	2.3	52.4	0.222	2480	0.945	4.1	486	96	11200	958
MI-13	48	12/13/2011	Rt side of berm	491.4	374.5	363.7	10.8	10	16-May-12	<0.0200	9090	2.35	53.5	0.235	2300	0.919	3.97	438	89.9	10800	938
MI-14	48	12/13/2011	Rt side of berm	451.1	335.0	317.4	17.6	11	16-May-12	<0.0200	8770	2.24	52.9	0.226	2530	0.916	4.08	457	85.9	10800	921
MI-15	48	12/13/2011	Rt side of berm	477.8	359.6	343.4	16.2	12	16-May-12	<0.0200	8780	2.25	52.4	0.233	2420	0.915	3.95	457	78.4	10900	917
MI-16	48	12/13/2011	Rt side of berm	417.1	310.7	292.8	17.9	13	16-May-12	<0.0200	8210	2.3	51.4	0.233	2420	0.878	4.01	478	108	10800	889
MI-17	48	12/13/2011	Rt side of berm	468.8	358.8	343.5	15.3	14	16-May-12	<0.0200	8450	2.3	52.3	0.235	2230	0.884	4.06	432	206	10700	862
MI-18	48	12/13/2011	Rt side of berm	455.6	344.7	331.1	13.6	15	16-May-12	<0.0200	7940	2.28	50.2	0.214	2190	0.839	3.68	416	86.1	10100	817
MI-19	48	12/13/2011	Middle 4 grids	457.0	368.7	359.9	8.8	1	16-May-12	<0.0200	9920	1.91	58.3	0.305	1410	0.954	4.85	427	22.8	11700	916
MI-20	48	12/13/2011	Middle 4 grids	471.1	389.2	386.5	2.7	2	16-May-12	<0.0200	10200	1.94	57.3	0.317	1240	0.942	4.87	392	24.8	11500	910
MI-21	48	12/13/2011	Middle 4 grids	469.2	383.4	379.8	3.6	3	16-May-12	<0.0200	10500	1.93	60.1	0.309	1320	0.979	4.94	408	24.4	11700	951
MI-22	48	12/14/2011	Rt side of berm	1378.5	1085.9	1035.5	50.4	1	16-May-12	<0.0200	7890	1.76	46.3	0.231	1660	0.735	3.16	262	112	8420	738
MI-23	48	12/14/2011	Rt side of berm	1375.3	1092.8	1035.6	57.2	2	18-May-12	0.354	10200	2.35	58.8	0.295	2060	1.05	4.01	329	106	10700	940
MI-24	48	12/14/2011	Rt side of berm	1411.3	1116.1	1064.3	51.8	3	18-May-12	0.143	8360	2	48.9	0.271	1720	0.807	3.4	294	93.1	9180	714
MI-25	48	12/14/2011	Rt side of berm	1501.8	1213.3	1170.5	42.8	4	18-May-12	0.206	8700	1.83	49.9	0.279	1660	0.804	3.45	253	165	9370	746
MI-26	48	12/14/2011	Rt side of berm	1400.9	1104.4	1072.5	31.9	5	18-May-12	0.173	8900	2.04	53.4	0.275	1930	0.813	3.56	278	127	9600	781
MI-27	48	12/14/2011	Rt side of berm	1461.9	1174.5	1127.3	47.2	6	18-May-12	0.106	8500	1.88	49.7	0.277	1700	0.763	3.37	265	114	9190	723
D1	1	12/13/2011	1	90.8	NA	NA	NA	NA	09-May-12	0.698	6770	1.15	40.4	0.266	1810	1.18	2.61	7.64	69	5970	559
D2	1	12/13/2011	2	47.1	NA	NA	NA	NA	09-May-12	0.724	7060	1.5	38	0.226	1330	1.08	2.16	8.25	69.2	6240	504
D3	1	12/13/2011	3	42.9	NA	NA	NA	NA	09-May-12	0.616	7920	2.03	28.3	0.183	464	1.04	1.82	9.3	33.3	7270	527
D4	1	12/13/2011	4	68.6	NA	NA	NA	NA	09-May-12	0.537	7620	1.61	35.8	0.206	1020	0.983	1.97	8.87	47.5	7000	604
D5	1	12/13/2011	5	52.7	NA	NA	NA	NA	09-May-12	0.485	8830	2.34	37.6	0.242	761	1.01	2.24	10.2	33.4	8120	586
D6	1	12/13/2011	6	60.0	NA	NA	NA	NA	09-May-12	0.564	5140	1.06	52.1	0.147	6330	0.899	2.67	5.54	44.8	4570	751
D7	1	12/13/2011	7	86.5	NA	NA	NA	NA	09-May-12	0.17	7940	1.45	44.1	0.411	529	0.815	3.69	8.81	16.7	7420	510
D8	1	12/13/2011	8	92.5	NA	NA	NA	NA	09-May-12	0.415	6650	1.03	41.2	0.262	1540	0.782	2.85	7.49	12.8	6230	632
D9	1	12/13/2011	9	51.3	NA	NA	NA	NA	09-May-12	0.578	4970	0.906	33.5	0.152	2850	0.721	2.05	5.34	7.31	4470	588
D10	1	12/13/2011	10	82.8	NA	NA	NA	NA	09-May-12	0.348	8260	1.28	48.8	0.223	2440	0.902	2.86	9.07	7.9	7750	724
D11	1	12/13/2011	11	87.7	NA	NA	NA	NA	09-May-12	0.34	8220	1.19	40.1	0.202	1570	0.872	3	9.09	7.22	7650	718
D12	1	12/13/2011	12	55.2	NA	NA	NA	NA	09-May-12	0.59	7190	2.31	35.2	0.321	1340	0.772	2.57	4.42	755	6390	541
D13	1	12/13/2011	13	88.0	NA	NA	NA	NA	09-May-12	0.395	7300	1.79	33.8	0.21	909	0.735	2.19	9.25	47	7100	532
D14	1	12/13/2011	14	70.3	NA	NA	NA	NA	09-May-12	0.184	7640	1.5	31	0.207	594	0.731	1.93	9.15	23	7040	593
D15	1	12/13/2011	15	84.3	NA	NA	NA	NA	09-May-12	2.22	4860	1.46	51.5	0.168	2700	0.624	2.41	5.82	18.8	4810	504
D16	1	12/13/2011	16	64.0	NA	NA	NA	NA	09-May-12	2.73	7050	1.65	35.6	0.179	1140	0.705	2.48	8.59	21.9	6540	601

Field Sample ID	Mg (mg/kg)	Mn (mg/kg)	Ni (mg/kg)	P (mg/kg)	Pb (mg/kg)	Sb (mg/kg)	Se (mg/kg)	Silica (mg/kg)	S (mg/kg)	Th (mg/kg)	V (mg/kg)	Zn (mg/kg)
MI-1	844	240	14	234	395	<0.0200	2.11	NA	NA	<0.0200	24.4	34.6
MI-2	866	253	18.7	239	509	0.17	2.61	NA	NA	<0.0200	24.7	34.3
MI-3	861	252	15.3	242	583	1.53	2.24	NA	NA	<0.0200	25	34.7
MI-4	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
MI-5	914	193	37	288	1260	16.3	3.41	NA	NA	0.137	25.7	35.7
MI-6	889	183	23.6	285	678	6.36	2.54	NA	NA	0.0528	25.8	36.3
MI-7	828	161	37	230	992	10.3	2.77	NA	NA	0.139	26.1	34.7
MI-8	781	156	23.8	229	1170	7.59	2.45	NA	NA	0.125	25.1	34.8
MI-9	817	153	18.4	217	862	4.47	2.17	NA	NA	0.0882	26	34
MI-10	873	155	25.8	258	714	6.66	2	NA	NA	0.0855	25.9	34.5
MI-11	876	162	17.1	265	639	1.89	1.96	NA	NA	0.032	25.3	33.2
MI-12	907	176	25.1	268	461	0.302	2.42	NA	NA	0.0346	25.3	32.6
MI-13	867	166	23.1	259	996	6.46	2.83	NA	NA	0.129	26.1	33.8
MI-14	858	168	23	275	971	8.75	2.72	NA	NA	0.113	24.9	34.1
MI-15	866	170	20.2	265	896	5.41	2.21	NA	NA	0.0484	25	33.7
MI-16	847	183	24.9	274	1030	5.9	2.33	NA	NA	0.0803	24.3	35.7
MI-17	823	187	33.1	256	1540	12.8	2.39	NA	NA	0.0719	24.9	36.5
MI-18	773	152	20.3	252	844	4.28	2.47	NA	NA	0.0672	23.8	32.3
MI-19	820	264	13.4	211	177	<0.0200	2.28	NA	NA	<0.0200	24.6	33.6
MI-20	813	247	13.2	195	267	<0.0200	1.68	NA	NA	<0.0200	25	33
MI-21	841	250	13.5	203	183	<0.0200	2.09	NA	NA	<0.0200	25.9	33.6
MI-22	685	128	22	198	969	6.3	1.91	NA	NA	0.0876	22.5	30.6
MI-23	864	157	23.3	249	1120	10.5	3.6	NA	NA	0.513	29.3	39.4
MI-24	730	130	19.9	217	1160	10.2	3.11	NA	NA	0.379	24.5	33.8
MI-25	768	132	31.3	210	1220	7.22	3.56	NA	NA	0.284	24.8	34.1
MI-26	789	147	25.2	229	884	8.6	2.91	NA	NA	0.296	25.1	35.6
MI-27	728	130	22.4	209	1190	8.48	3.13	NA	NA	0.266	24.7	33.6
D1	652	130	12.7	168	422	1.68	1.27	NA	NA	0.499	15.4	30.9
D2	647	113	14.4	157	1360	4.01	2.09	NA	NA	0.466	19.6	29.2
D3	581	34.8	8.82	161	227	<0.0200	2.76	NA	NA	0.315	27.3	22.2
D4	615	69.3	9.73	212	199	<0.0200	2.43	NA	NA	0.285	24	25.3
D5	678	46.4	9.23	168	368	0.0955	1.69	NA	NA	0.252	33.6	28.7
D6	820	768	10.1	403	222	0.076	3.26	NA	NA	<0.0200	15.7	48.1
D7	634	215	6.93	176	149	<0.0200	1.5	NA	NA	<0.0200	21.3	25.7
D8	651	229	5.49	184	117	<0.0200	1.56	NA	NA	<0.0200	14.4	24.7
D9	704	327	4.07	218	30.9	<0.0200	1.57	NA	NA	<0.0200	11.3	27.6
D10	801	300	5.84	209	20	<0.0200	2.17	NA	NA	<0.0200	18.4	32.8
D11	758	249	5.47	216	48.6	<0.0200	3.05	NA	NA	<0.0200	16.5	24.5
D12	591	91	92.8	262	8770	69.6	2.18	NA	NA	0.33	23.7	36.6
D13	647	75.5	7.72	134	360	12	1.87	NA	NA	<0.0200	28.3	24.8
D14	592	36.8	6.47	154	224	<0.0200	1.37	NA	NA	0.0801	24.6	22.2
D15	621	259	11.4	359	173	0.0234	2.4	NA	NA	<0.0200	19	30.2

Field Sample ID	Number of Field Increments	Sample Date	Grid Location	Wet Mass (g)	Total Dry Mass (g)	< 2mm Mass (g)	> 2mm Mass (g)	Field Replicate	Analysis Date	Ag (mg/kg)	Al (mg/kg)	As (mg/kg)	Ba (mg/kg)	Be (mg/kg)	Ca (mg/kg)	Cd (mg/kg)	Co (mg/kg)	Cr (mg/kg)	Cu (mg/kg)	Fe (mg/kg)	K (mg/kg)
D16	1	12/13/2011	16	64.0	NA	NA	NA	NA	09-May-12	2.73	7050	1.65	35.6	0.179	1140	0.705	2.48	8.59	21.9	6540	601
D17	1	12/13/2011	17	57.6	NA	NA	NA	NA	09-May-12	<0.0200	7200	1.95	36.9	0.243	1160	0.495	2.59	8.61	30.7	6620	527
D18	1	12/13/2011	18	89.0	NA	NA	NA	NA	09-May-12	1.38	10500	1.65	49.3	0.337	1090	0.951	3.59	10.9	17.7	9410	669
D19	1	12/13/2011	19	95.4	NA	NA	NA	NA	09-May-12	0.711	7500	1.34	43.5	0.216	1630	0.775	2.82	8.53	10.7	6970	653
D20	1	12/13/2011	20	90.6	NA	NA	NA	NA	09-May-12	0.384	7890	1.26	33.6	0.209	910	0.768	2.92	9.16	8.16	7750	692
D21	1	12/13/2011	21	95.1	NA	NA	NA	NA	09-May-12	0.277	7370	1.09	41	0.231	1680	0.746	2.82	8.04	7.31	7120	615
D22	1	12/13/2011	22	97.1	NA	NA	NA	NA	09-May-12	0.227	8530	1.45	36.4	0.197	1570	0.836	2.77	9.56	8.07	9440	751
D23	1	12/13/2011	23	93.7	NA	NA	NA	NA	09-May-12	0.234	5010	1.57	36.2	0.163	3920	0.654	2.61	6.63	18.3	5600	570
D24	1	12/13/2011	24	71.0	NA	NA	NA	NA	09-May-12	0.269	5670	1.23	50	0.311	2300	0.648	2.49	7.22	17.1	5050	438
D25	1	12/13/2011	25	54.3	NA	NA	NA	NA	09-May-12	0.294	4960	0.792	29	0.131	1010	0.53	1.85	6.54	11.9	4460	396
D26	1	12/13/2011	26	69.5	NA	NA	NA	NA	09-May-12	0.2	5980	0.906	30.3	0.201	624	0.559	2.1	7.4	11.6	5320	436
D27	1	12/13/2011	27	83.0	NA	NA	NA	NA	09-May-12	0.108	7640	1.19	38.8	0.28	548	0.655	3.26	8.88	11.2	6510	497
D28	1	12/13/2011	28	102.1	NA	NA	NA	NA	09-May-12	0.128	8660	1.2	43.1	0.255	945	0.721	4.14	10	13.2	7850	580
D29	1	12/13/2011	29	59.6	NA	NA	NA	NA	09-May-12	0.175	8010	1.26	51.4	0.298	1640	0.677	3.36	8.92	10.5	6990	552
D30	1	12/13/2011	30	115.6	NA	NA	NA	NA	09-May-12	3.66	6790	0.962	52.7	0.307	1110	0.697	3.44	7.47	10.9	5660	474
D31	1	12/13/2011	31	114.7	NA	NA	NA	NA	09-May-12	1.16	6640	1.02	51.1	0.349	1640	0.604	3.99	7.06	8.39	5680	493
D32	1	12/13/2011	32	109.9	NA	NA	NA	NA	09-May-12	1.14	6040	0.876	37.5	0.269	1070	0.613	3.03	7.74	8.43	5720	551
D33	1	12/13/2011	33	77.9	NA	NA	NA	NA	09-May-12	0.692	7460	0.92	41.9	0.384	863	0.643	3.48	8.14	8.98	6330	512

Field Sample ID	Mg (mg/kg)	Mn (mg/kg)	Ni (mg/kg)	P (mg/kg)	Pb (mg/kg)	Sb (mg/kg)	Se (mg/kg)	Silica (mg/kg)	S (mg/kg)	Th (mg/kg)	V (mg/kg)	Zn (mg/kg)
D16	604	63.3	8.81	270	262	0.337	3.18	NA	NA	<0.0200	29	28.5
D17	638	201	7.88	188	488	<0.0200	2.34	NA	NA	<0.0200	25.7	22.6
D18	777	131	8.82	150	137	<0.0200	2.45	NA	NA	<0.0200	25.4	34.5
D19	683	243	5.74	178	52.5	<0.0200	1.98	NA	NA	<0.0200	17.4	29
D20	629	232	4.83	155	54.9	<0.0200	1.68	NA	NA	<0.0200	18.4	21.2
D21	710	309	5.04	180	24.6	<0.0200	1.69	NA	NA	<0.0200	16.3	31.5
D22	791	201	5.58	161	58.6	<0.0200	3.16	NA	NA	<0.0200	19.3	31.6
D23	1080	197	7.29	314	94.3	<0.0200	2.44	NA	NA	<0.0200	12	40.9
D24	598	210	6.78	148	94.9	<0.0200	1.93	NA	NA	<0.0200	15.3	44.9
D25	483	66.1	4.53	128	46.3	<0.0200	0.888	NA	NA	<0.0200	17.5	22
D26	510	66.8	4.86	146	49.1	<0.0200	0.791	NA	NA	<0.0200	17.9	21
D27	634	89.9	6.72	160	51.1	<0.0200	1.68	NA	NA	<0.0200	24.6	25.4
D28	770	196	6.46	149	53.3	<0.0200	2.12	NA	NA	<0.0200	21.7	23.9
D29	763	244	6.85	169	34.2	<0.0200	2.72	NA	NA	<0.0200	21.9	25.8
D30	646	230	5.16	125	17.6	<0.0200	1.88	NA	NA	<0.0200	15.6	25.5
D31	677	333	5.1	153	55.6	<0.0200	1.81	NA	NA	<0.0200	14.7	25.4
D32	573	242	4.48	168	18	<0.0200	1.3	NA	NA	<0.0200	13.2	28
D33	649	257	5.49	200	24.7	<0.0200	2.3	NA	NA	<0.0200	15.4	29.2

Appendix E: Results for Fort Wainwright

Field Sample ID	Number of Field Increments	Sample Date	Grid Location	Wet Mass (g)	Dry Total Mass (g)	< 2mm Mass (g)	> 2mm Mass (g)	Field Replicate	Analysis Date	Ag (mg/kg)	Al (mg/kg)	As (mg/kg)	Ba (mg/kg)	Be (mg/kg)	Ca (mg/kg)	Cd (mg/kg)	Co (mg/kg)	Cr (mg/kg)	Cu (mg/kg)	Fe (mg/kg)
Bck01a	96	10/3/2011	Background	1956.6	1271.7	1129	128.5	1												
Bck01b	100	10/3/2011	Background	2589.2	1673.6	1450.0	194.1	2												
Bck01c	100	10/3/2011	Background	2600.2	1660.7	NA	NA	3	NA	0.334	12400	15.4	208	0.119	12700	2.12	13	168	38.2	22700
BckD01a	1	10/3/2011	Background	77.7	NA	NA	NA	NA	11/15/11	<2.00	14000	13.7	162	<2.00	6380	<2.00	13.3	28.8	36.9	26300
BckD01b	1	10/3/2011	Background	49.4	NA	NA	NA	NA	11/15/11	<2.00	9180	9.92	139	<2.00	9880	<2.00	9.11	17.7	22.6	16900
BckD01b	1	10/3/2011	Background	49.4	NA	NA	NA	NA	12/14/11	<2.00	8340	7.97	120	<2.00	8490	<2.00	8.82	16.7	21.2	16500
BckD01c	1	10/3/2011	Background	77.0	NA	NA	NA	NA	11/15/11	<2.00	11500	14.1	143	<2.00	7830	<2.00	11.3	23.1	26.3	23200
D01a	1	10/3/2011	upper left	162.4	NA	NA	NA	NA	11/15/11	<2.00	10000	8.45	101	<2.00	5380	<2.00	9.69	18.9	26.4	17800
D01b	1	10/3/2011	upper right	145.9	NA	NA	NA	NA	11/15/11	<2.00	10400	9.93	114	<2.00	5860	<2.00	9.32	19.1	23.4	17700
D01c	1	10/3/2011	lower center	130.3	NA	NA	NA	NA	11/15/11	<2.00	10700	8.58	107	<2.00	5640	<2.00	9.95	20.1	34.1	19000
D02a	1	10/3/2011	upper left	135.0	NA	NA	NA	NA	11/15/11	<2.00	9990	8.77	102	<2.00	5420	<2.00	9.65	19.7	29.2	18400
D02b	1	10/3/2011	upper right	174.7	NA	NA	NA	NA	11/15/11	<2.00	10500	8.17	94.5	<2.00	5040	<2.00	9.1	20.3	20.2	18800
D02c	1	10/3/2011	lower center	152.1	NA	NA	NA	NA	11/15/11	<2.00	11000	9.04	123	<2.00	6260	<2.00	10	20.5	41	19700
D03a	1	10/3/2011	upper left	161.9	NA	NA	NA	NA	11/15/11	<2.00	9890	9.07	99.6	<2.00	5520	<2.00	9.27	18.1	27.5	18200
D03b	1	10/3/2011	upper right	161.7	NA	NA	NA	NA	11/15/11	<2.00	10200	8.3	96.4	<2.00	5600	<2.00	9.51	19	23.1	18600
D03c	1	10/3/2011	lower center	146.5	NA	NA	NA	NA	11/15/11	<2.00	10900	8.88	110	<2.00	5890	<2.00	10.2	20.4	43.7	19800
D04a	1	10/3/2011	upper left	179.0	NA	NA	NA	NA	11/15/11	<2.00	10100	9.29	102	<2.00	6300	<2.00	9.36	19.1	23.5	18400
D04b	1	10/3/2011	upper right	165.0	NA	NA	NA	NA	11/15/11	<2.00	10400	8.56	99.2	<2.00	5490	<2.00	9.78	19.8	25	18700
D04c	1	10/3/2011	lower center	140.4	NA	NA	NA	NA	11/15/11	<2.00	10500	10.2	115	<2.00	6060	<2.00	9.82	19.5	27	19200
D05a	1	10/3/2011	upper left	184.0	NA	NA	NA	NA	11/15/11	<2.00	10000	8.52	100	<2.00	5550	<2.00	9.76	18.8	26.2	18300
D05b	1	10/3/2011	upper right	196.9	NA	NA	NA	NA	11/15/11	<2.00	9960	9.34	106	<2.00	5590	<2.00	9.12	18.1	212	18400
D05c	1	10/3/2011	lower center	180.6	NA	NA	NA	NA	11/15/11	<2.00	10400	8.33	104	<2.00	5740	<2.00	9.45	19.8	295	18700
D06a	1	10/3/2011	upper left	170.5	NA	NA	NA	NA	11/15/11	<2.00	9670	8.71	118	<2.00	5050	<2.00	9.18	19.1	23.9	17900
D06b	1	10/3/2011	upper right	148.9	NA	NA	NA	NA	11/15/11	<2.00	9330	8.1	116	<2.00	4890	<2.00	8.92	18.3	32.4	17100
D06c	1	10/3/2011	lower center	153.3	NA	NA	NA	NA	11/15/11	<2.00	10300	8.85	107	<2.00	7720	<2.00	9.59	19.3	30.3	18800
D07a	1	10/3/2011	upper left	179.4	NA	NA	NA	NA	11/15/11	<2.00	14200	12.7	106	<2.00	7550	<2.00	11.4	19.6	41.9	18900
D07b	1	10/3/2011	upper right	160.3	NA	NA	NA	NA	11/15/11	<2.00	9940	8.13	97.2	<2.00	4990	<2.00	9.47	19	24.8	18000
D07c	1	10/3/2011	lower center	154.0	NA	NA	NA	NA	11/15/11	<2.00	9600	8.5	109	<2.00	4940	<2.00	8.93	18.2	53.2	17900
D08a	1	10/3/2011	upper left	181.8	NA	NA	NA	NA	11/15/11	<2.00	10800	9.24	136	<2.00	6300	<2.00	9.97	19.5	30	19500
D08b	1	10/3/2011	upper right	153.9	NA	NA	NA	NA	11/15/11	<2.00	9800	10.2	109	<2.00	5140	<2.00	9.2	18.4	852	17800
D08c	1	10/3/2011	lower center	157.8	NA	NA	NA	NA	11/15/11	<2.00	10500	8.95	114	<2.00	5650	<2.00	9.86	20.3	35.9	19300
D09a	1	10/3/2011	upper left	103.4	NA	NA	NA	NA	11/15/11	<2.00	11900	11.6	115	<2.00	9010	<2.00	11.1	21.1	27.9	22700
D09b	1	10/3/2011	upper right	121.2	NA	NA	NA	NA	11/15/11	<2.00	11200	10.4	103	<2.00	8380	<2.00	10.6	20.1	27.4	21700
D09c	1	10/3/2011	lower center	114.6	NA	NA	NA	NA	11/15/11	<2.00	11500	10.9	107	<2.00	8740	<2.00	11	20.5	27.8	22600
D10a	1	10/3/2011	upper left	150.8	NA	NA	NA	NA	11/15/11	<2.00	10300	11.5	118	<2.00	5600	<2.00	9.32	19.7	457	18400
D10b	1	10/3/2011	upper right	161.5	NA	NA	NA	NA	11/15/11	<2.00	9990	12.3	99.6	<2.00	5760	<2.00	9.4	18.2	825	17900
D10c	1	10/3/2011	lower center	135.4	NA	NA	NA	NA	11/15/11	<2.00	10800	9.28	170	<2.00	6320	<2.00	11.4	22.6	26.6	20300
D11a	1	10/3/2011	upper left	181.7	NA	NA	NA	NA	11/15/11	<2.00	10300	8.9	100	<2.00	5730	<2.00	9.64	20	23.6	18400
D11b	1	10/3/2011	upper right	143.6	NA	NA	NA	NA	11/15/11	<2.00	10100	8.22	105	<2.00	5680	<2.00	9.13	19	24.2	18000
D11c	1	10/3/2011	lower center	174.3	NA	NA	NA	NA	11/15/11	<2.00	9530	8.64	104	<2.00	5220	<2.00	8.98	18.5	34.3	17800
D12a	1	10/3/2011	upper left	166.6	NA	NA	NA	NA	11/15/11	<2.00	10000	7.21	108	<2.00	5150	<2.00	8.82	18.4	24.2	17300
D12b	1	10/3/2011	upper right	165.8	NA	NA	NA	NA	11/15/11	<2.00	11000	8.1	102	<2.00	5890	<2.00	9.85	20.7	26.9	19100

Field Sample ID	K (mg/kg)	Mg (mg/kg)	Mn (mg/kg)	Na (mg/kg)	Ni (mg/kg)	P (mg/kg)	Pb (mg/kg)	Sb (mg/kg)	Se (mg/kg)	Silica (mg/kg)	S (mg/kg)	Th (mg/kg)	V (mg/kg)	Zn (mg/kg)	NG (mg/kg)
Bck01a															NA
Bck01b															NA
Bck01c	2100	6260	721	562	25.8	828	416	<0.0200	8.96	NA	NA	<0.0200	38.2	74	NA
BckD01a	2410	7740	556	694	29.4	576	8.08	<2.00	<2.00	39.7	285	<2.00	48.4	66.4	NA
BckD01b	1250	5220	467	439	18.5	598	136	<2.00	<2.00	48.4	595	<2.00	29.7	63.7	NA
BckD01b	1010	4950	425	361	17.7	520	96.4	<2.00	2.2	153	461	<2.00	27.4	57.1	NA
BckD01c	1200	5730	418	414	22.1	503	14.3	<2.00	<2.00	36.8	485	<2.00	37.3	47	NA
D01a	1010	5260	296	486	21.7	500	96.9	<2.00	<2.00	43.5	129	<2.00	35.3	47.4	NA
D01b	1200	5120	283	502	20.6	478	50.7	<2.00	<2.00	61.7	88.7	<2.00	36	44.3	NA
D01c	1270	5490	306	548	22.2	517	109	<2.00	<2.00	48.4	114	<2.00	37.4	49.8	NA
D02a	1070	5310	297	469	21.6	531	89.8	<2.00	<2.00	43.2	130	<2.00	35.6	50.7	NA
D02b	913	5260	276	476	20.6	443	24.1	<2.00	<2.00	47.7	69.4	<2.00	34.4	44.9	NA
D02c	1150	5570	315	560	22.3	563	41.1	<2.00	<2.00	65.2	93.6	<2.00	38.1	50.9	NA
D03a	972	5230	293	454	21	503	123	<2.00	<2.00	55.5	128	<2.00	34.1	48.3	NA
D03b	1010	5340	299	525	21.6	503	20.4	<2.00	<2.00	51.8	91.2	<2.00	36.3	47	NA
D03c	1130	5650	319	532	22.8	516	17.8	<2.00	<2.00	58	95.7	<2.00	38.5	52.3	NA
D04a	938	5380	295	493	21.7	568	21.4	<2.00	<2.00	55.1	134	<2.00	34.5	47.9	NA
D04b	987	5420	293	492	22.3	499	61.4	<2.00	<2.00	44.6	94.7	<2.00	36.8	48.3	NA
D04c	1050	5400	313	533	22.1	541	114	<2.00	<2.00	62.5	86.1	<2.00	36.1	49	NA
D05a	949	5240	288	470	22.2	568	199	<2.00	<2.00	45.3	120	<2.00	34.9	48.9	NA
D05b	953	5190	283	445	20.7	575	1670	11.2	<2.00	43.5	93.2	<2.00	34.8	70.4	NA
D05c	940	5520	292	440	21.5	496	929	3.61	<2.00	38.8	79.6	<2.00	39.2	75.6	NA
D06a	923	5110	289	427	21	499	69.7	<2.00	<2.00	46.8	105	<2.00	34	47.1	NA
D06b	975	4960	281	428	20.3	469	180	<2.00	<2.00	23.9	109	<2.00	32.6	45.5	NA
D06c	1050	5610	305	501	22.1	579	145	<2.00	<2.00	50.4	189	<2.00	35.9	50.1	NA
D07a	1340	5900	341	744	22.3	457	497	<2.00	<2.00	42	581	<2.00	40.4	51.7	NA
D07b	927	5160	275	434	21.6	490	78.6	<2.00	<2.00	29.6	96.3	<2.00	35.4	46.3	NA
D07c	1170	5210	282	429	20.8	494	972	3.04	<2.00	25.3	98.8	<2.00	34.4	49.8	NA
D08a	1060	5430	300	550	22.5	536	264	<2.00	<2.00	47.8	138	<2.00	36.6	50.7	NA
D08b	1090	5220	287	445	21	510	3570	29.6	<2.00	72.6	102	<2.00	35.5	140	NA
D08c	1030	5610	308	519	22.1	524	432	<2.00	<2.00	44.6	112	<2.00	37.4	51	NA
D09a	1050	6410	372	733	24.2	673	5.23	<2.00	<2.00	135	78.6	<2.00	41.4	50	NA
D09b	1020	6170	363	680	23	620	6	<2.00	<2.00	111	72.7	<2.00	40.2	46.8	NA
D09c	1060	6540	384	689	24.2	656	5.9	<2.00	<2.00	60.2	69.3	<2.00	41.3	49	NA
D10a	1070	5260	285	489	21.3	504	3820	32.6	<2.00	69.9	94.4	<2.00	35.3	101	NA
D10b	1020	5040	301	502	21.9	519	4500	27.2	<2.00	45.6	123	<2.00	34.8	146	NA
D10c	998	6310	351	633	25.3	576	105	<2.00	<2.00	43.9	292	<2.00	34.6	47.3	NA
D11a	986	5230	283	506	21.7	513	50.9	<2.00	<2.00	62.5	105	<2.00	36.2	47.8	NA
D11b	1030	5170	289	499	20.6	503	38.5	<2.00	<2.00	67.6	115	<2.00	35.9	46.3	NA
D11c	992	5030	285	431	20.1	549	288	<2.00	<2.00	35.2	78.4	<2.00	33.6	45.9	NA
D12a	1180	5180	254	452	20	566	121	<2.00	<2.00	60.8	99.6	<2.00	34.4	46	NA
D12b	1060	5620	298	539	22	506	72.3	<2.00	<2.00	43.6	93.4	<2.00	37.5	47.9	NA

Field Sample ID	Number of Field Increments	Sample Date	Grid Location	Wet Mass (g)	Dry Total Mass (g)	< 2mm Mass (g)	> 2mm Mass (g)	Field Replicate	Analysis Date	Ag (mg/kg)	Al (mg/kg)	As (mg/kg)	Ba (mg/kg)	Be (mg/kg)	Ca (mg/kg)	Cd (mg/kg)	Co (mg/kg)	Cr (mg/kg)	Cu (mg/kg)	Fe (mg/kg)
D12c	1	10/3/2011	lower center	177.8	NA	NA	NA	NA	11/15/11	<2.00	1060	<2.00	10.6	<2.00	529	<2.00	<2.00	2.04	2.58	1960
D13a	1	10/3/2011	upper left	173.5	NA	NA	NA	NA	11/15/11	<2.00	10100	8.07	107	<2.00	5270	<2.00	9.43	18.1	28.1	18000
D13b	1	10/3/2011	upper right	151.8	NA	NA	NA	NA	11/15/11	<2.00	8310	6.32	87.8	<2.00	4450	<2.00	7.75	16.5	22.9	14700
D13c	1	10/3/2011	lower center	169.1	NA	NA	NA	NA	11/15/11	<2.00	9450	7.83	99.1	<2.00	4670	<2.00	8.96	18.1	30.8	17600
D14a	1	10/3/2011	upper left	135.0	NA	NA	NA	NA	11/15/11	<2.00	9980	8.36	98.9	<2.00	5090	<2.00	9.44	20.5	34.6	17900
D14b	1	10/3/2011	upper right	161.2	NA	NA	NA	NA	11/15/11	<2.00	10100	7.67	108	<2.00	5480	<2.00	9.16	19.4	23.5	17400
D14c	1	10/3/2011	lower center	162.4	NA	NA	NA	NA	11/15/11	<2.00	8890	6.23	93.2	<2.00	4260	<2.00	8.47	16.7	25.6	16100
D15a	1	10/3/2011	upper left	166.7	NA	NA	NA	NA	11/15/11	<2.00	10500	9	107	<2.00	5510	<2.00	9.66	19.6	48.8	18800
D15b	1	10/3/2011	upper right	157.0	NA	NA	NA	NA	11/15/11	<2.00	10600	8.1	102	<2.00	5750	<2.00	9.79	20.6	26.7	19000
D15c	1	10/3/2011	lower center	165.4	NA	NA	NA	NA	11/15/11	<2.00	6930	6.26	66.2	<2.00	3470	<2.00	7.24	14.8	43.4	13900
D16a	1	10/3/2011	upper left	176.3	NA	NA	NA	NA	11/15/11	<2.00	9230	7.97	95.7	<2.00	4700	<2.00	9.45	18.9	26	18800
D16b	1	10/3/2011	upper right	150.4	NA	NA	NA	NA	11/15/11	<2.00	9150	8.26	98.9	<2.00	4440	<2.00	9.8	18.7	25.9	19000
D16c	1	10/3/2011	lower center	181.0	NA	NA	NA	NA	11/15/11	<2.00	9030	8.24	97.6	<2.00	4490	<2.00	9.83	19.3	24.3	18600
FTWW MI-01	96	10/4/2011	Entire Berm	2648.5	2480.6	1494.2	978.6	1	20-Dec-11	<2.00	12700	7.32	148	<2.00	6900	<2.00	10.7	271	54.5	21500
FTWW MI-02	96	10/4/2011	Entire Berm	2662.0	2525.1	1528.4	987.6	2	20-Dec-11	<2.00	13100	7.54	151	<2.00	7140	<2.00	10.9	264	74.4	21600
FTWW MI-03	96	10/4/2011	Entire Berm	2641.9	2500.0	1537.5	948.3	3	20-Dec-11	<2.00	13200	7.33	148	<2.00	7200	<2.00	10.8	268	96.9	21500
FTWW MI-04	96	10/4/2011	Entire Berm	2245.9	2114.2	1313.5	787.9	4	20-Dec-11	<2.00	13500	6.93	152	<2.00	7270	<2.00	10.9	298	130	22000
FTWW MI-05	96	10/4/2011	Entire Berm	1995.2	1882.5	1149.4	723.3	5	20-Dec-11	<2.00	12700	7.07	143	<2.00	6920	<2.00	10.7	319	60.5	21800
FTWW MI-06	96	10/4/2011	Entire Berm	2341.3	2215.5	1402.3	807.7	6	20-Dec-11	<2.00	13700	7.13	157	<2.00	7210	<2.00	11	286	39.5	21800
FTWW MI-07	96	10/4/2011	Entire Berm	2087.1	1961.7	1227.4	722.6	7	20-Dec-11	<2.00	12900	7.24	148	<2.00	6970	<2.00	10.8	313	42.6	21700
FTWW MI-08	96	10/4/2011	Entire Berm	2287.4	2163.9	1318.9	839.3	8	20-Dec-11	<2.00	13100	7.21	151	<2.00	7100	<2.00	10.9	300	191	21800
FTWW MI-09	96	10/4/2011	Entire Berm	2163.6	2040.7	1299.2	729.3	9	20-Dec-11	<2.00	13300	7.26	148	<2.00	7210	<2.00	10.9	303	72.9	21700
FTWW MI-10	96	10/4/2011	Entire Berm	2652.5	2511.3	1439.5	1059	10	20-Dec-11	<2.00	12800	6.58	142	<2.00	7070	<2.00	10.5	276	104	20900
FTWW MI-11	96	10/4/2011	Entire Berm	2728.8	2574.2	1547.3	1019	11	20-Dec-11	<2.00	12400	6.69	138	<2.00	6820	<2.00	10.3	254	65.6	20700
FTWW MI-12	96	10/4/2011	Entire Berm	2847.1	2697.1	1606.3	1075	12	20-Dec-11	<2.00	12000	6.75	136	<2.00	6570	<2.00	10.3	246	49.3	20600
FTWW MI-13	96	10/4/2011	Entire Berm	2222.1	2090.5	1315.4	769.5	13	20-Dec-11	<2.00	12700	7.1	144	<2.00	6870	<2.00	10.7	293	47.6	21500
FTWW MI-14	96	10/4/2011	Entire Berm	2159.1	2027.6	1264.2	755.9	14	20-Dec-11	<2.00	13000	7.33	147	<2.00	7060	<2.00	10.7	310	247	21800
FTWW MI-15	96	10/4/2011	Entire Berm	2356.5	2215.6	NA	NA	15	20-Dec-11	0.27	13100	7.11	151	0.0317	7100	1.66	10.9	312	104	22200
FTWW MI-16	30	10/4/2011	Berm 11 R	824.2	783.5	429.7	349.2	1	20-Dec-11	<2.00	13200	6.86	152	<2.00	7070	<2.00	10.6	340	108	21400
FTWW MI-17	30	10/4/2011	Berm 11 L	796.5	763.0	413.4	346.7	1	20-Dec-11	<2.00	12800	7.48	148	<2.00	6720	<2.00	10.9	329	66.5	21700
FTWW MI-18	30	10/4/2011	Berm 11 R	902.8	861.1	497.0	361.3	2	20-Dec-11	<2.00	12700	7.19	147	<2.00	6820	<2.00	10.4	262	50.4	20800
FTWW MI-19	30	10/4/2011	Berm 11 L	788.7	756.0	416.1	335.7	2	20-Dec-11	<2.00	12700	7.18	146	<2.00	6730	<2.00	10.5	309	304	20900
FTWW MI-20	30	10/4/2011	Berm 11 R	780.9	743.2	415.5	323.2	3	20-Dec-11	<2.00	12000	7.24	142	<2.00	6490	<2.00	10.1	318	172	20800
FTWW MI-21	30	10/4/2011	Berm 11 L	551.5	526.0	308.2	213.2	3	20-Dec-11	<2.00	12800	6.94	151	<2.00	6700	<2.00	10.6	383	172	21600
FTWW MI-22	30	10/4/2011	Berm 11 R	844.7	803.6	449.5	350.5	4	14-Dec-11	<2.00	6220	3.56	74.4	<2.00	3460	<2.00	5.33	152	26.1	10900
FTWW MI-23	30	10/4/2011	Berm 11 L	743.4	711.4	406.2	301.6	4	20-Dec-11	<2.00	12300	7.02	144	<2.00	6520	<2.00	10.4	287	272	20900
FTWW MI-24	30	10/4/2011	Berm 11 R	960.7	916.8	545.5	365.1	5	20-Dec-11	<2.00	11600	6.97	140	<2.00	6250	<2.00	9.94	237	72.4	19900
FTWW MI-25	30	10/4/2011	Berm 11 L	770.0	738.8	428.5	305.7	5	20-Dec-11	<2.00	12000	6.8	136	<2.00	6380	<2.00	10.2	291	99	20600
FTWW MI-26	30	10/4/2011	Berm 11 R	787.0	743.8	464.0	275.2	6	20-Dec-11	<2.00	12800	6.69	163	<2.00	7150	<2.00	10.4	291	113	21000
FTWW MI-27	30	10/4/2011	Berm 11 L	663.0	632.3	393.3	235.9	6	20-Dec-11	<2.00	13400	7.35	156	<2.00	7010	<2.00	10.8	340	69.7	21800
FTWW MI-28	30	10/4/2011	Berm 11 R	836.9	798.3	435.7	357.9	7	20-Dec-11	<2.00	12600	6.97	150	<2.00	6760	<2.00	10.1	302	79.7	20600
FTWW MI-29	30	10/4/2011	Berm 11 L	723.9	691.0	439.9	294.4	7	20-Dec-11	<2.00	12600	6.96	144	<2.00	6660	<2.00	10.4	285	117	20900
FTWW MI-30	30	10/4/2011	Berm 11 R	852.1	815.2	451.8	358.7	8	20-Dec-11	<2.00	12800	6.94	149	<2.00	6960	<2.00	10.5	313	151	21000
FTWW MI-31	30	10/4/2011	Berm 11 L	848.1	804.4	501.6	297.4	8	20-Dec-11	<2.00	12300	7.81	145	<2.00	6530	<2.00	10.5	260	165	21200

Field Sample ID	K (mg/kg)	Mg (mg/kg)	Mn (mg/kg)	Na (mg/kg)	Ni (mg/kg)	P (mg/kg)	Pb (mg/kg)	Sb (mg/kg)	Se (mg/kg)	Silica (mg/kg)	S (mg/kg)	Th (mg/kg)	V (mg/kg)	Zn (mg/kg)	NG (mg/kg)
D12c	112	558	29.5	44.7	2.26	50.8	5.01	<2.00	<2.00	3.83	9.13	<2.00	3.59	4.88	NA
D13a	993	5180	282	474	20.7	476	156	<2.00	<2.00	62.3	82	<2.00	36	46.4	NA
D13b	918	4290	234	396	16.8	459	49.1	<2.00	<2.00	43	75.4	<2.00	29.3	35.6	NA
D13c	918	4850	274	422	20	454	81.5	<2.00	<2.00	32	106	<2.00	32.9	45.1	NA
D14a	1250	5320	290	434	22.8	508	74	<2.00	<2.00	54.3	135	<2.00	34.6	48.1	NA
D14b	1020	5180	276	463	21	460	24.8	<2.00	<2.00	37.8	97.9	<2.00	34.7	45.1	NA
D14c	817	4600	258	338	19.3	441	144	<2.00	<2.00	19.9	62.9	<2.00	30.2	40	NA
D15a	1110	5340	293	505	21.6	518	565	2.43	<2.00	50	90.2	<2.00	36.6	50.9	NA
D15b	1090	5360	296	497	22.4	492	11.6	<2.00	<2.00	51.8	98.3	<2.00	36.9	47.1	NA
D15c	724	4110	213	254	17.4	413	748	2.07	<2.00	88.7	83.7	<2.00	28.1	37.7	NA
D16a	972	5310	292	319	22	551	36.8	<2.00	<2.00	91.8	133	<2.00	33.4	47.8	NA
D16b	856	5390	309	311	22.4	517	30.5	<2.00	<2.00	71.1	116	<2.00	33.6	48.3	NA
D16c	866	5250	317	307	22.4	524	40.6	<2.00	<2.00	88.6	106	<2.00	32.9	47.7	NA
FTWW MI-01	1740	5870	342	760	25.7	529	562	<2.00	2.68	237	99.8	<2.00	40.9	51.6	283
FTWW MI-02	1860	5960	346	791	25.8	545	489	<2.00	2.41	256	103	<2.00	42.3	56	251
FTWW MI-03	1820	5820	342	793	26.2	527	732	<2.00	2.68	157	86.5	<2.00	42.6	56.5	236
FTWW MI-04	1900	5920	347	821	25.7	525	405	<2.00	2.72	253	87.9	<2.00	43.8	59.8	213
FTWW MI-05	1800	5810	346	764	25.9	530	333	<2.00	2.31	164	87.9	<2.00	41.5	52.2	202
FTWW MI-06	1970	5820	344	829	25.5	521	311	<2.00	2.48	176	81.6	<2.00	44.1	50.8	208
FTWW MI-07	1830	5800	342	775	26.6	524	379	<2.00	2.36	277	98.4	<2.00	41.7	50.4	443
FTWW MI-08	1800	5760	338	791	25.9	535	480	<2.00	2.58	241	97.4	<2.00	42.7	68	397
FTWW MI-09	1860	5860	350	806	25.5	523	356	<2.00	2.46	213	87.1	<2.00	42.6	53.8	475
FTWW MI-10	1800	5710	336	775	24.9	517	495	<2.00	2.35	217	78.7	<2.00	42.1	55.2	384
FTWW MI-11	1650	5560	328	760	24.2	511	468	<2.00	2.35	169	84.8	<2.00	40.4	50.9	374
FTWW MI-12	1590	5530	326	722	24.6	516	487	<2.00	2.31	192	86.3	<2.00	39.7	49.8	326
FTWW MI-13	1760	5800	346	754	25.7	529	362	<2.00	2.55	167	83.8	<2.00	41.5	51.3	404
FTWW MI-14	1850	5830	345	791	25.6	526	550	<2.00	2.5	170	88	<2.00	41.5	74.3	341
FTWW MI-15	1900	5990	348	801	26.5	540	380	<0.0200	7.9	NA	NA	<0.0200	41.5	56.9	491
FTWW MI-16	1860	5620	335	806	25.3	518	420	<2.00	2.2	191	91.1	<2.00	43.1	58.9	NA
FTWW MI-17	1780	5650	330	758	26.5	526	748	<2.00	2.3	297	93	<2.00	41.9	54	NA
FTWW MI-18	1750	5650	333	758	24.7	525	604	<2.00	2.17	219	89.4	<2.00	41.6	51.7	NA
FTWW MI-19	1790	5550	332	761	25.7	513	984	<2.00	2.68	250	79.1	<2.00	41.5	79	NA
FTWW MI-20	1700	5460	328	722	24.6	518	621	<2.00	2.9	166	86.9	<2.00	39.7	65.8	NA
FTWW MI-21	1910	5620	336	783	25.9	502	790	<2.00	2.25	216	86.1	<2.00	40.5	65	NA
FTWW MI-22	883	2910	174	13	290	302	<2.00	<2.00	125	397	61.8	<2.00	20.9	27.2	NA
FTWW MI-23	1710	5520	326	728	24.9	501	927	<2.00	2.52	176	84.3	<2.00	40.2	75.8	NA
FTWW MI-24	1580	5420	315	703	23.7	515	527	<2.00	2.38	250	91.5	<2.00	38.3	52.8	NA
FTWW MI-25	1690	5530	327	695	24.4	505	774	<2.00	2.18	169	86.7	<2.00	39.6	55.2	NA
FTWW MI-26	1820	5650	341	777	24.8	540	499	<2.00	2.33	170	96.8	<2.00	41.2	59.9	NA
FTWW MI-27	1960	5870	351	811	25.5	517	795	<2.00	2.35	193	93.3	<2.00	43.1	53.9	NA
FTWW MI-28	1770	5460	326	777	24.3	510	528	<2.00	2.06	335	93	<2.00	40.6	53.5	NA
FTWW MI-29	1740	5580	330	748	24.6	507	852	<2.00	2.68	171	75.1	<2.00	41.3	57.7	NA
FTWW MI-30	1790	5570	334	796	25	521	541	<2.00	2.09	255	88.1	<2.00	41.8	62.1	NA
FTWW MI-31	1690	5680	335	720	25.1	519	1460	3.15	2.02	184	99.6	<2.00	40.5	65.5	NA

Field Sample ID	Number of Field Increments	Sample Date	Grid Location	Wet Mass (g)	Dry Total Mass (g)	< 2mm Mass (g)	> 2mm Mass (g)	Field Replicate	Analysis Date	Ag (mg/kg)	Al (mg/kg)	As (mg/kg)	Ba (mg/kg)	Be (mg/kg)	Ca (mg/kg)	Cd (mg/kg)	Co (mg/kg)	Cr (mg/kg)	Cu (mg/kg)	Fe (mg/kg)
FTWW MI-32	30	10/4/2011	Berm 11 R	864.2	828.2	425.8	400.5	9	20-Dec-11	<2.00	12200	7.18	142	<2.00	6670	<2.00	10.2	301	71.6	20500
FTWW MI-33	30	10/4/2011	Berm 11 L	775.6	736.7	451.0	280.1	9	20-Dec-11	<2.00	13400	7.1	153	<2.00	7070	<2.00	10.8	309	243	21800
FTWW MI-34	30	10/4/2011	Berm 11 R	679.4	648.9	375.0	268.7	10	20-Dec-11	<2.00	12900	7.05	152	<2.00	6960	<2.00	10.6	361	81.5	21400
FTWW MI-35	30	10/4/2011	Berm 11 L	827.7	789.9	455.9	326.2	10	20-Dec-11	<2.00	12800	7.06	149	<2.00	6760	<2.00	10.4	293	44.7	20900
FTWW MI-36	30	10/4/2011	Berm 11 R	802.2	766.8	401.7	360.2	11	20-Dec-11	<2.00	13000	7.32	155	<2.00	7030	<2.00	10.5	322	122	21300
FTWW MI-37	30	10/4/2011	Berm 11 L	772.5	736.7	466.5	264.1	11	20-Dec-11	<2.00	13000	7.42	149	<2.00	6920	<2.00	10.8	297	70.3	21300
FTWW MI-38	30	10/4/2011	Berm 11 R	795.0	759.1	430.1	326.7	12	20-Dec-11	<2.00	12500	7.31	147	<2.00	6790	<2.00	10.2	300	254	20800
FTWW MI-39	30	10/4/2011	Berm 11 L	753.3	718.3	443.7	271.4	12	20-Dec-11	<2.00	12900	7.18	148	<2.00	6810	<2.00	10.6	294	108	21100
FTWW MIFP01	96	10/4/2011	FP	2483.9	2333.1	1551.5	763.2	1	20-Dec-11	<2.00	13300	9.02	226	<2.00	6830	<2.00	11.1	223	162	22300
FTWW MIFP02	96	10/4/2011	FP	2642.7	2485.1	1688.4	783.3	2	20-Dec-11	<2.00	13100	8.49	211	<2.00	6650	<2.00	11.2	212	144	22500
FTWW MIFP03	96	10/4/2011	FP	2584.3	2425.9	1642.5	769.4	3	20-Dec-11	<2.00	12600	8.97	210	<2.00	6370	<2.00	10.9	204	150	21600
FTWW MIFP04	96	10/4/2011	FP	2779.7	2586.8	1604.5	954.7	4	20-Dec-11	<2.00	13300	8.66	203	<2.00	6900	<2.00	11	229	134	21800
FTWW MIFP05	96	10/4/2011	FP	2672.2	2499.4	1581.1	887.1	5	20-Dec-11	<2.00	13100	8.72	197	<2.00	6850	<2.00	10.9	230	141	21900
FTWW MIFP06	96	10/4/2011	FP	2639.4	2464.7	1521.1	919.9	6	20-Dec-11	<2.00	13000	8.67	201	<2.00	6690	<2.00	11.1	253	158	22200
FTWW MIFP07	96	10/4/2011	FP	2120.2	2008.2	1422.1	552.3	7	20-Dec-11	<2.00	13400	8.53	268	<2.00	6700	<2.00	11.1	238	248	22500
FTWW MIFP08	96	10/4/2011	FP	2244.7	2123.9	1486.7	608.9	8	14-Dec-11	<2.00	6950	4.59	139	<2.00	3570	<2.00	5.95	119	124	12000
FTWW MIFP09	96	10/4/2011	FP	2219.1	2105.7	1453.0	623.1	9	14-Dec-11	<2.00	6810	4.6	136	<2.00	3550	<2.00	5.86	120	117	11800
FTWW MIFP10	96	10/4/2011	FP	2565.6	2437.2	1555.5	849.0	10	14-Dec-11	<2.00	6460	4.34	124	<2.00	3360	<2.00	5.61	111	108	11500
FTWW MIFP11	96	10/4/2011	FP	2574.2	2441.7	1543.7	870.3	11	14-Dec-11	<2.00	6810	4.42	127	<2.00	3550	<2.00	5.86	112	104	11600
FTWW MIFP12	96	10/4/2011	FP	2220.0	2096.7	1366.3	704.0	12	14-Dec-11	<2.00	6960	4.85	119	<2.00	3630	<2.00	5.91	130	88	11800
FTWW MIFP13	96	10/4/2011	FP	2070.7	1959.6	1256.6	673.4	13	14-Dec-11	<2.00	6760	4.53	132	<2.00	3590	<2.00	5.84	141	112	11600
FTWW MIFP14	96	10/4/2011	FP	2574.0	2449.6	1603.5	825.8	14	14-Dec-11	<2.00	6470	4.43	117	<2.00	3290	<2.00	5.71	111	95.8	11600
FTWW MIFP15	96	10/4/2011	FP	2237.5	2124.8	1363.5	737.6	15												

Field Sample ID	K (mg/kg)	Mg (mg/kg)	Mn (mg/kg)	Na (mg/kg)	Ni (mg/kg)	P (mg/kg)	Pb (mg/kg)	Sb (mg/kg)	Se (mg/kg)	Silica (mg/kg)	S (mg/kg)	Th (mg/kg)	V (mg/kg)	Zn (mg/kg)	NG (mg/kg)
FTWW MI-32	1710	5430	323	753	26.5	510	568	<2.00	2.16	273	80.4	<2.00	39.9	52	NA
FTWW MI-33	1890	5780	345	784	25.5	517	682	<2.00	2.59	190	87.9	<2.00	42.8	74	NA
FTWW MI-34	1910	5660	343	814	25.5	530	586	<2.00	2.14	180	87.2	<2.00	42	54.8	NA
FTWW MI-35	1830	5690	334	755	24.8	504	590	<2.00	2.41	246	92.1	<2.00	41.3	52.9	NA
FTWW MI-36	1880	5650	343	819	25.9	528	432	<2.00	2.17	233	81.3	<2.00	42.1	59.3	NA
FTWW MI-37	1840	5810	338	770	25.6	513	913	<2.00	2.55	241	93.9	<2.00	42.4	53.9	NA
FTWW MI-38	1800	5600	339	768	24.8	519	722	<2.00	2.33	193	81.5	<2.00	40.4	72.1	NA
FTWW MI-39	1810	5680	334	770	25.8	507	636	<2.00	2.52	186	86.5	<2.00	42	57.3	NA
FTWW MIFP01	2180	6090	380	765	26.6	589	50	<2.00	2.44	167	208	<2.00	44.4	68.9	NA
FTWW MIFP02	2100	6070	377	742	26.2	585	76.2	<2.00	2.55	181	185	<2.00	44.5	64.4	NA
FTWW MIFP03	2010	5880	360	717	26.1	576	45.7	<2.00	2.59	204	192	<2.00	42.2	67.1	NA
FTWW MIFP04	2200	5990	376	787	26.3	575	39.3	<2.00	2.79	191	192	<2.00	44.1	64.8	NA
FTWW MIFP05	2170	5990	371	755	27.2	573	37.9	<2.00	2.79	164	192	<2.00	43.4	62.7	NA
FTWW MIFP06	2210	6020	373	759	28.4	583	37.3	<2.00	2.68	206	202	<2.00	43.5	73.1	NA
FTWW MIFP07	2340	6090	383	766	26.1	610	67.2	<2.00	2.44	151	289	<2.00	44.2	82.6	NA
FTWW MIFP08	1170	3290	204	14.5	343	36.6	<2.00	<2.00	64.5	400	124	<2.00	23.6	40	NA
FTWW MIFP09	1170	3190	198	13.8	340	37.2	<2.00	<2.00	72.8	406	129	<2.00	23.3	38.2	NA
FTWW MIFP10	1060	3140	194	13.7	319	31.4	<2.00	<2.00	85.6	385	113	<2.00	22.1	36.3	NA
FTWW MIFP11	1110	3170	199	13.6	326	32	<2.00	<2.00	60.2	399	117	<2.00	22.9	36	NA
FTWW MIFP12	1200	3170	198	13.7	331	27.4	<2.00	<2.00	67.4	418	127	<2.00	23.7	35.7	NA
FTWW MIFP13	1210	3120	197	13.7	331	34.9	<2.00	<2.00	76.5	412	136	<2.00	23.3	45.2	NA
FTWW MIFP14	1040	3110	195	13.9	328	28.9	<2.00	<2.00	53.6	367	119	<2.00	22.1	37	NA
FTWW MIFP15															NA

Appendix F: Statistical Summary of Kimama Data

Introduction

The incremental samples (IS) were collected from a small-arms berm and prepared by compositing 86–102 increments. The mass (dry weight) of the IS ranged from about 0.8–1.6 kg. The IS were ground in a puck mill (5 60-s grinds). Each IS subsample mass was about 2 g and was prepared in the laboratory from 20 randomly sampling aliquots. The grab subsample mass was 1 g. The metals of interest were predominately Pb, Zn, and Cu. Sb was not evaluated as most of the Sb results were non-detections. All concentration units were in mg/kg. Appendix F-1 presents descriptive statistics for select metals for the three data sets:

- "Berm IS" (n = 13)—Incremental samples from the berm.
- "BKG IS" (n = 2)—Background incremental samples.
- "Grab" (n = 30)—Soil grabs from berm.

Appendix F-2 presents boxplots and individual value plots for Pb, Cu, and Zn. Appendix F-3 presents normal probability plots. Appendix F-4 presents statistical tests for variances. All statistical tests were done at the 95% level of confidence (unless otherwise specified).

Discussion and conclusions

1. Based on a qualitative evaluation of the boxplots and individual value plots in Appendix F-2, the berm exhibits elevated concentrations of Pb, Cu, and Zn relative to the background.

2. Incremental sampling tends to normalize concentration measurements. The normal probability plot and symmetrical boxplot for the Pb "Berm IS" data (Appendix F-2) indicate the results are normally distributed. In contrast, the Pb "Grab" results for the berm are lognormal rather than normal. The Cu "Berm IS" results are not normally distributed but are approximately lognormal. However, the Cu "Grab" results are not normal or

lognormal. The Zn “Berm IS” and “Grab” data are both consistent with a normal distribution.

3. As shown in Appendix F-2, the grab samples tend to exhibit larger variability. The boxplot for the Pb “Grab” data indicates that the distribution is positively skewed and possesses one very large outlier. In contrast, the Pb “Berm IS” data set is consistent with a normal distribution and does not possess any outliers. The Cu “Grab” and “Berm IS” data sets are both positively skewed, but only the “Grab” data set exhibits outliers.

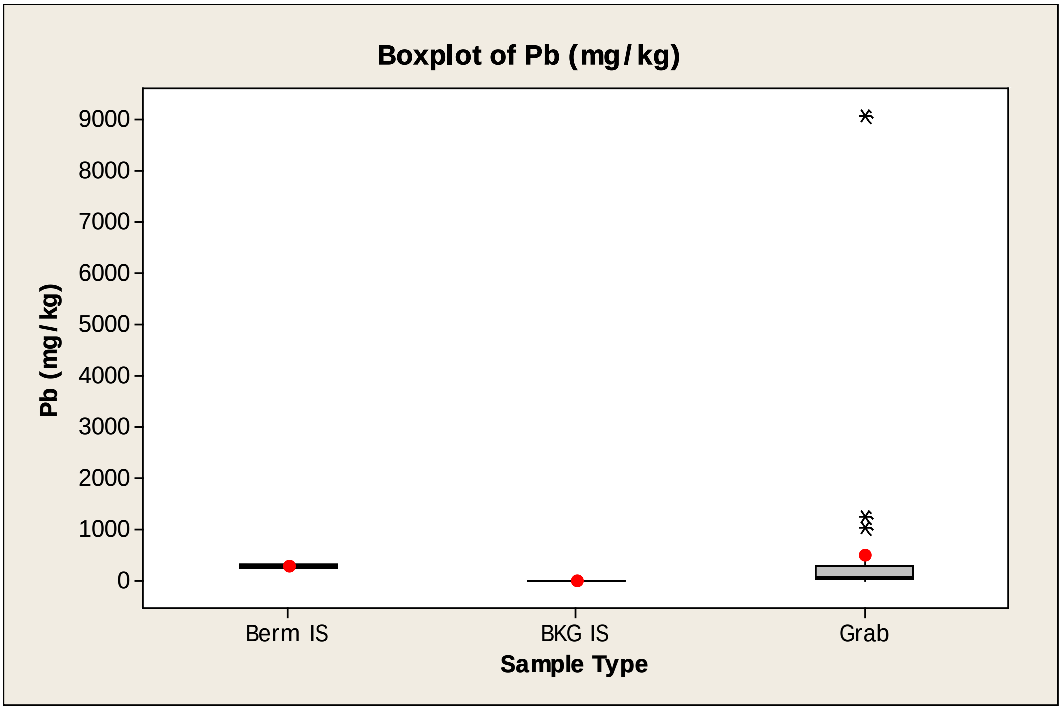
4. As shown in Appendix F-4, after the Pb results are subject to a logarithm (base 10) transformation, the F-test and Levene’s test indicate that the variance of the “Grab” data set is significantly larger than the variance of the “Berm IS” data set. Both the F-test and Levene’s test indicate that the Zn “Grab” variance is significantly larger than the Zn “Berm IS” variance. However, the Levene’s test for the variances did not detect significant differences between the “Grab” Cu variance and the Cu “Berm IS” variance.

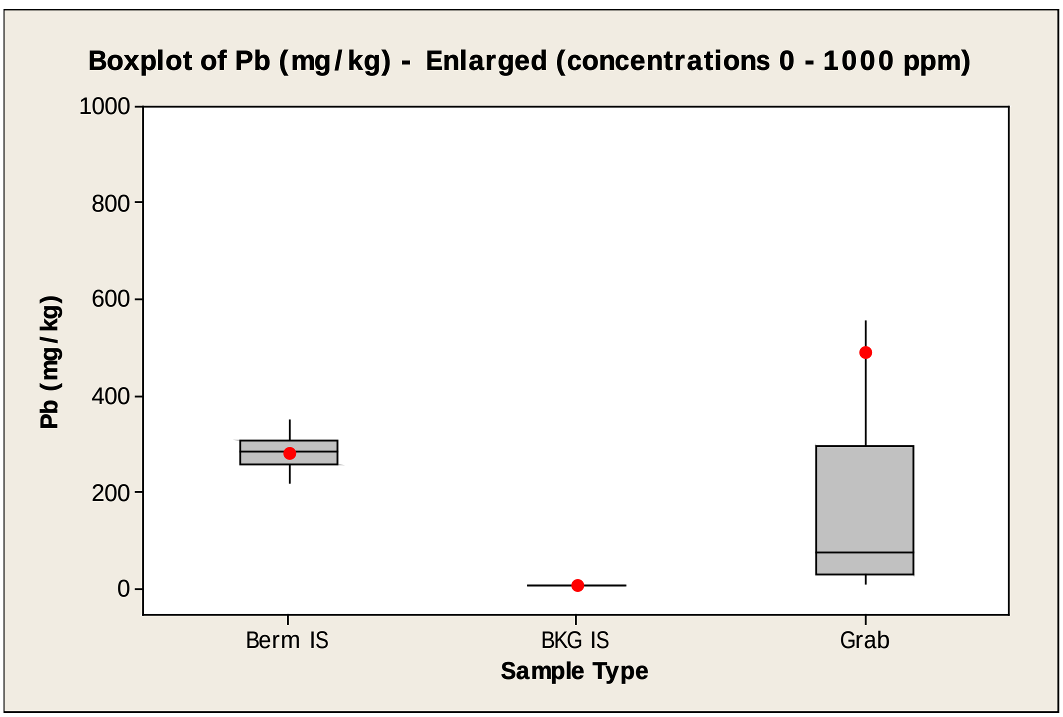
5. Appendix F-5 presents two sample hypotheses tests to compare the “Grab” and “Berm IS” means or medians. The “Berm IS” Pb and Cu medians are significantly larger than the “Grab” means and medians. However, the Zn “Grab” mean and median are significantly larger than the Zn “Berm IS” median. It is not clear why the incremental samples resulted in smaller Zn concentrations than the grab samples.

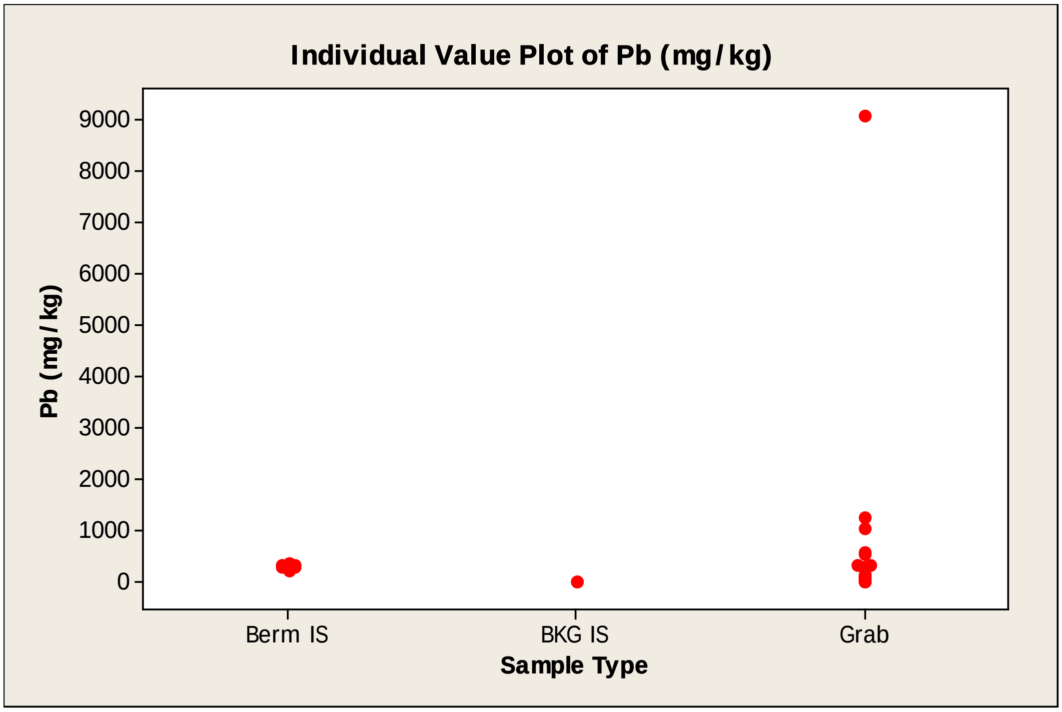
Appendix F-1: Descriptive statistics for select metals

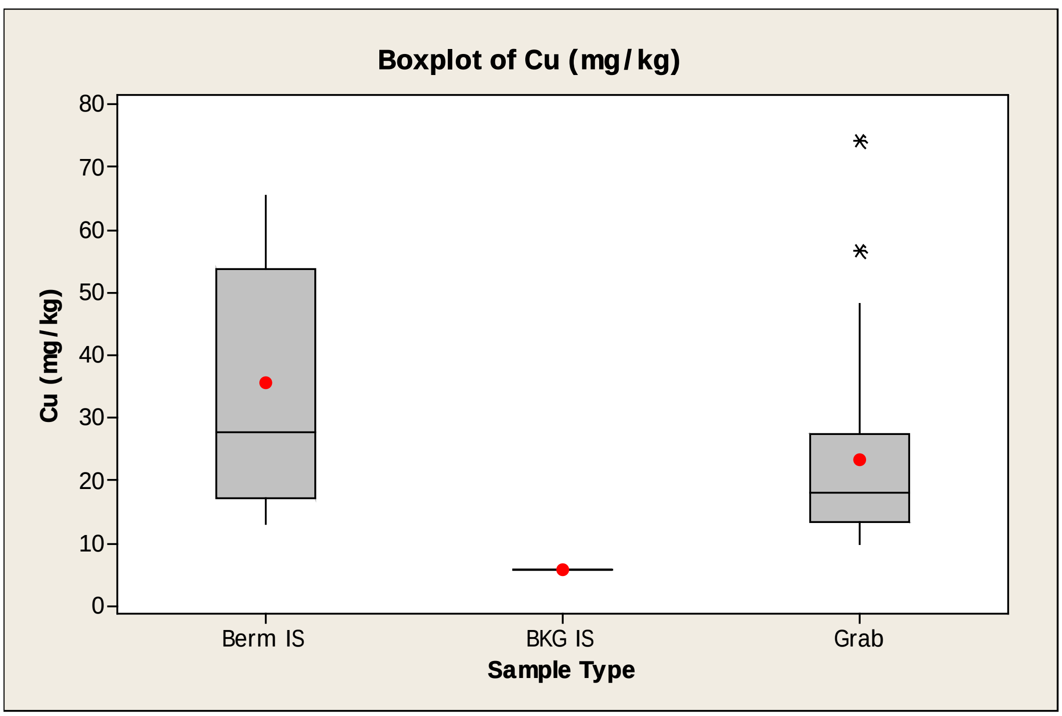
Variable	Sample Type	N	Mean	StDev	Minimum	Median	Maximum
Al (mg/kg)	Berm IS	13	4724.6	124.1	4580.0	4690.0	4980.0
	BKG IS	2	4070	156	3960	4070	4180
	Grab	30	6854	939	3030	6955	8340
Ba (mg/kg)	Berm IS	13	55.000	1.565	53.300	54.300	58.700
	BKG IS	2	52.400	0.566	52.000	52.400	52.800
	Grab	30	70.25	13.96	30.30	69.45	120.00
Ca (mg/kg)	Berm IS	13	1247.7	33.2	1200.0	1250.0	1310.0
	BKG IS	2	1295.0	7.07	1290.0	1295.0	1300.0
	Grab	30	1983	1274	892	1750	8490
Cr (mg/kg)	Berm IS	13	134.77	18.48	105.00	131.00	172.00
	BKG IS	2	117.50	7.78	112.00	117.50	123.00
	Grab	30	15.747	1.872	7.810	15.900	18.500
Cu (mg/kg)	**Berm IS**	**13**	**35.61**	**19.37**	**13.00**	**27.80**	**65.50**
	BKG IS	**2**	**5.6900**	**0.0283**	**5.6700**	**5.6900**	**5.7100**
	Grab	**30**	**23.23**	**15.51**	**9.83**	**18.05**	**74.20**
Fe (mg/kg)	Berm IS	13	6726.2	155.6	6570.0	6710.0	7040.0
	BKG IS	2	6465.0	49.5	6430.0	6465.0	6500.0
	Grab	30	10092	1684	4690	10050	16500
K (mg/kg)	Berm IS	13	1330.0	63.9	1240.0	1320.0	1460.0
	BKG IS	2	1050.0	70.7	1000.0	1050.0	1100.0
	Grab	30	1734.6	279.8	799.0	1820.0	2120.0
Mg (mg/kg)	Berm IS	13	1340.8	20.6	1310.0	1340.0	1380.0
	BKG IS	2	1255.0	21.2	1240.0	1255.0	1270.0
	Grab	30	2262	576	1030	2185	4950
Mn (mg/kg)	Berm IS	13	120.46	2.54	117.00	120.00	125.00
	BKG IS	2	111.50	0.707	111.00	111.50	112.00
	Grab	30	204.60	50.50	93.90	197.50	425.00
Na (mg/kg)	Berm IS	13	137.38	12.53	121.00	135.00	167.00
	BKG IS	2	121.00	0.000000	121.00	121.00	121.00
	Grab	30	75.2	55.0	28.7	63.4	361.0
Ni (mg/kg)	Berm IS	13	7.5623	0.2308	7.3300	7.4800	8.0200
	BKG IS	2	6.7950	0.00707	6.7900	6.7950	6.8000
	Grab	30	10.741	1.813	5.150	10.700	17.700
Pb (mg/kg)	**Berm IS**	**13**	**281.77**	**35.85**	**220.00**	**284.00**	**350.00**
	BKG IS	**2**	**5.370**	**0.283**	**5.170**	**5.370**	**5.570**
	Grab	**30**	**491**	**1645**	**11**	**74**	**9060**
V (mg/kg)	Berm IS	13	13.215	0.422	12.600	13.200	14.100
	BKG IS	2	12.850	0.636	12.400	12.850	13.300
	Grab	30	18.228	2.829	8.350	18.150	27.400
Zn (mg/kg)	**Berm IS**	**13**	**28.246**	**1.994**	**25.700**	**27.900**	**31.200**
	BKG IS	**2**	**25.700**	**0.141**	**25.600**	**25.700**	**25.800**
	Grab	**30**	**45.56**	**7.12**	**21.80**	**44.90**	**57.10**

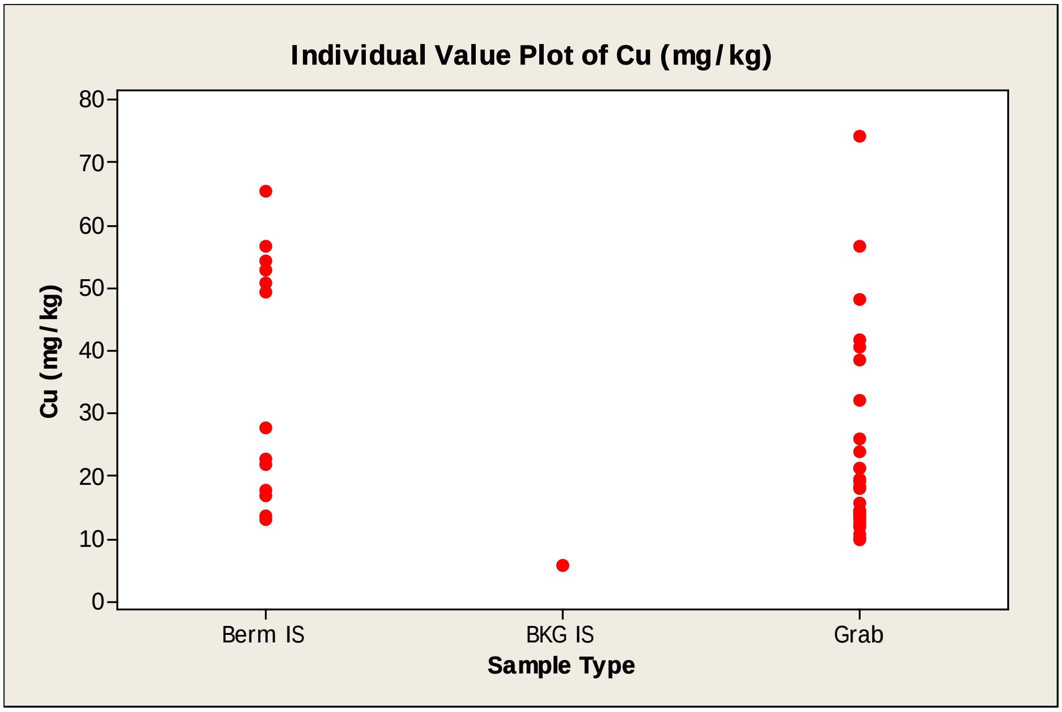
Appendix F-2: Boxplots

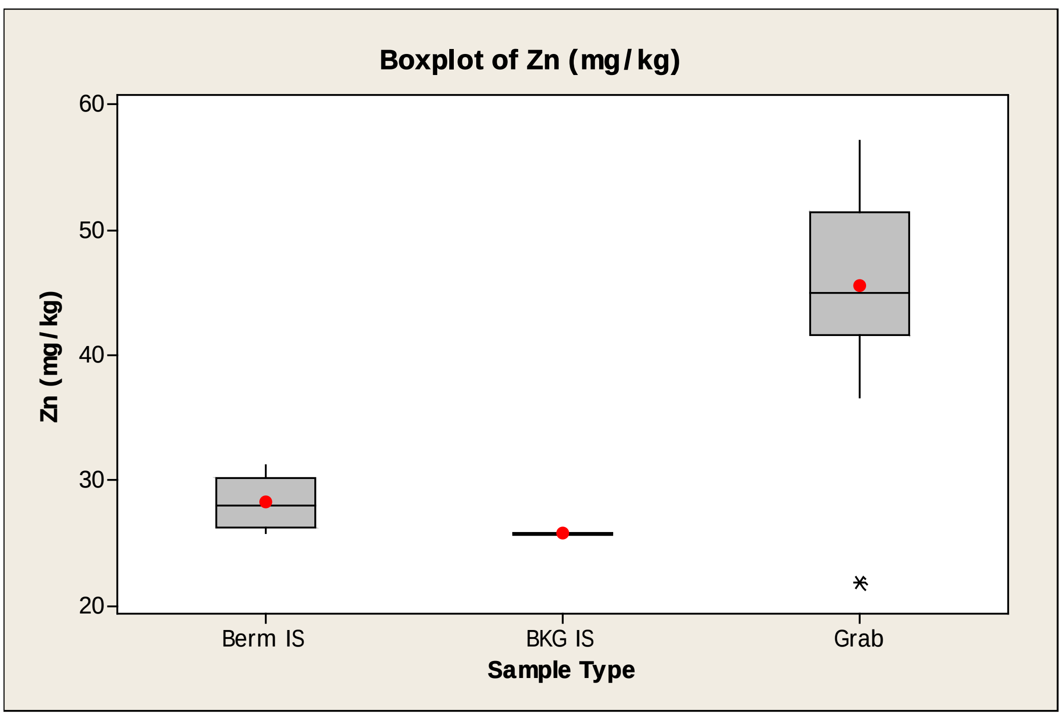


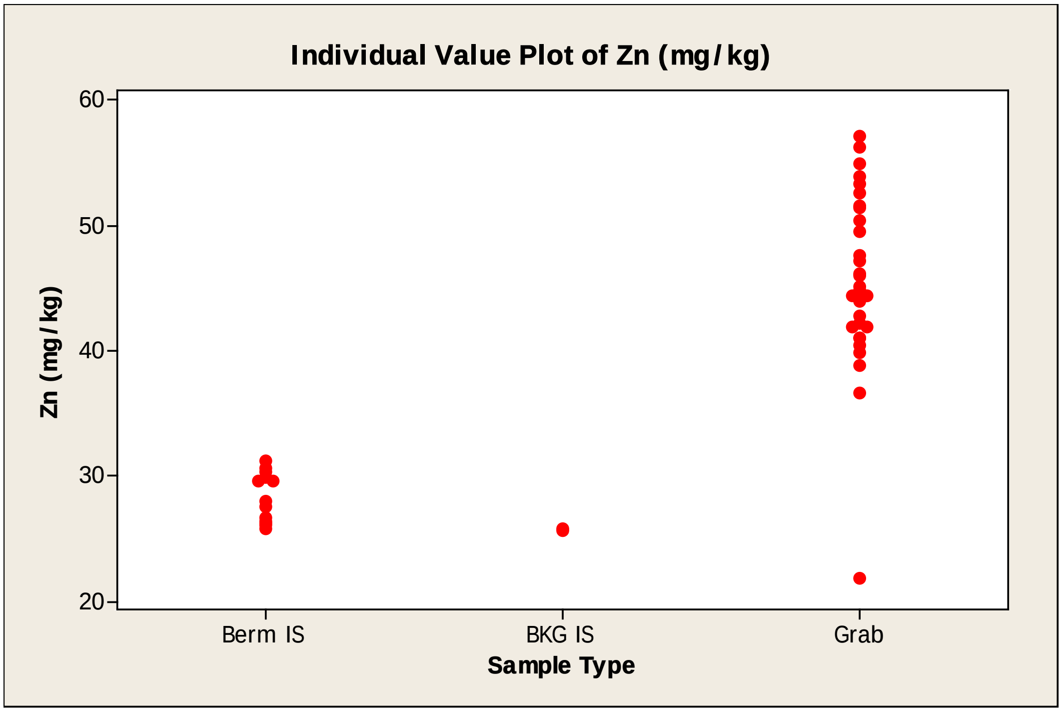



Individual Value Plot of Pb (mg/kg)
Pb (mg/kg)
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
Berm IS
BKG IS
Grab
Sample Type


Boxplot of Cu (mg/kg)
Cu (mg/kg)
80
70
60
50
40
30
20
10
0
Berm IS
BKG IS
Grab
Sample Type

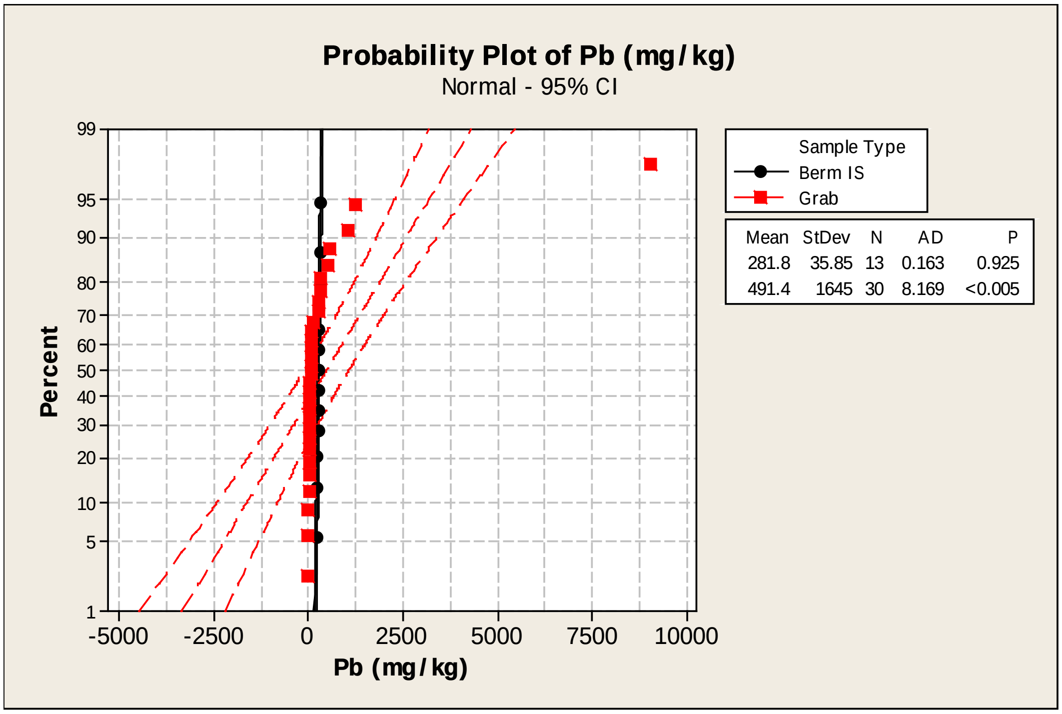

Individual Value Plot of Cu (mg/kg)
Cu (mg/kg)
80
70
60
50
40
30
20
10
0
Berm IS
BKG IS
Grab
Sample Type

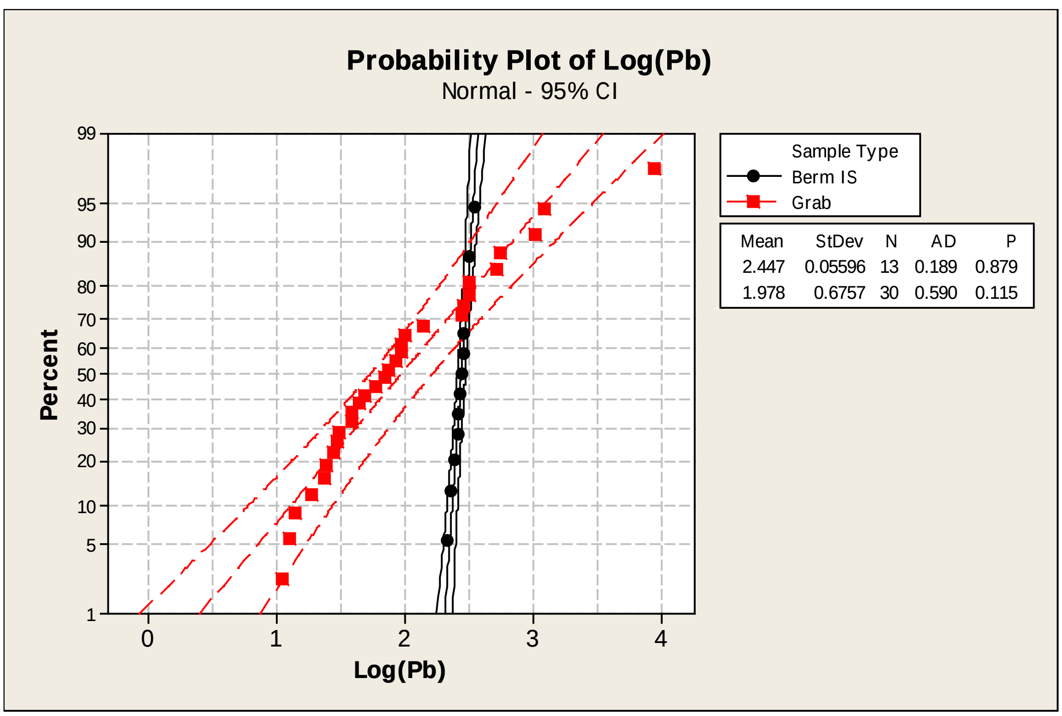

Boxplot of Zn (mg/kg)
Zn (mg/kg)
60
50
40
30
20
Berm IS
BKG IS
Grab
Sample Type

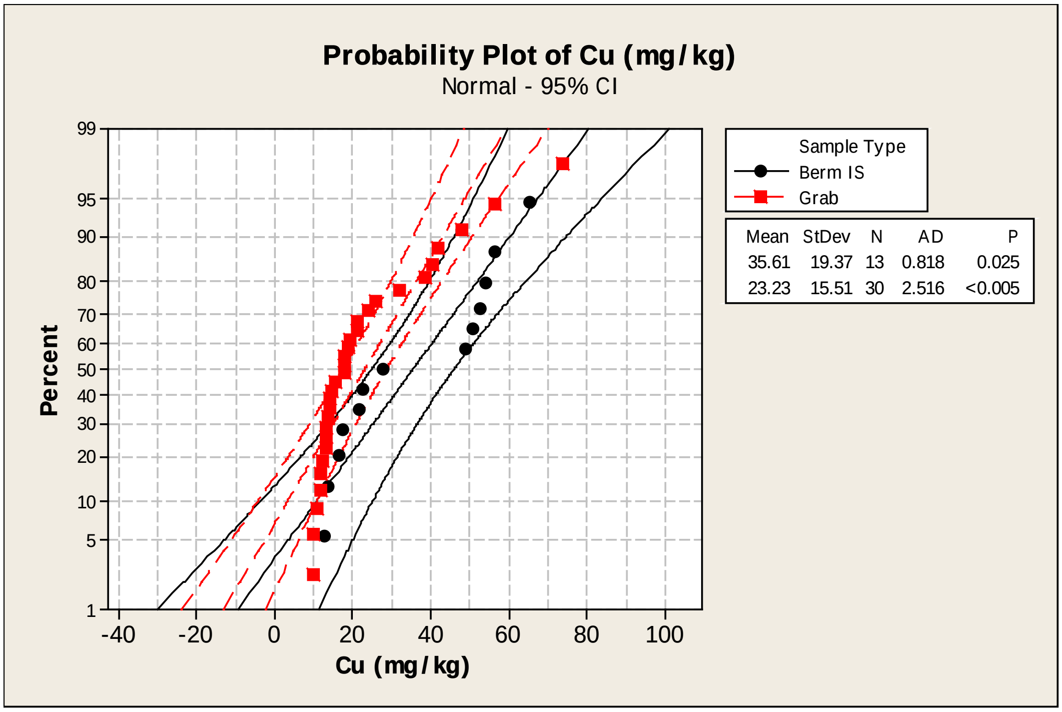


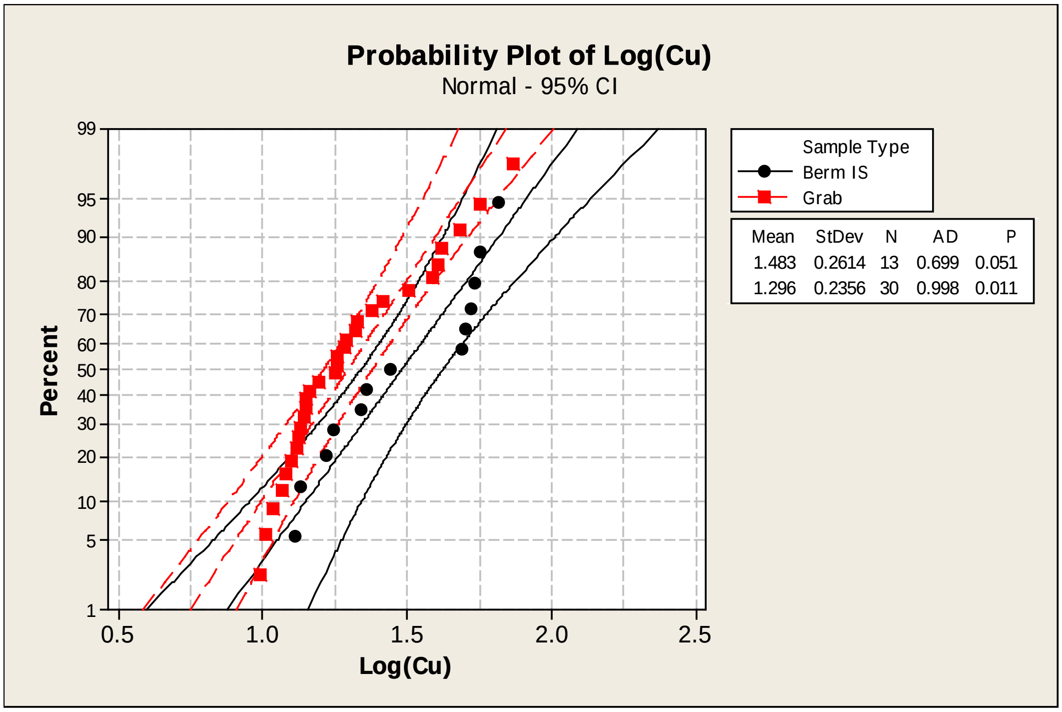
Individual Value Plot of Zn (mg/kg)
Zn (mg/kg)
60
50
40
30
20
Berm IS
BKG IS
Grab
Sample Type

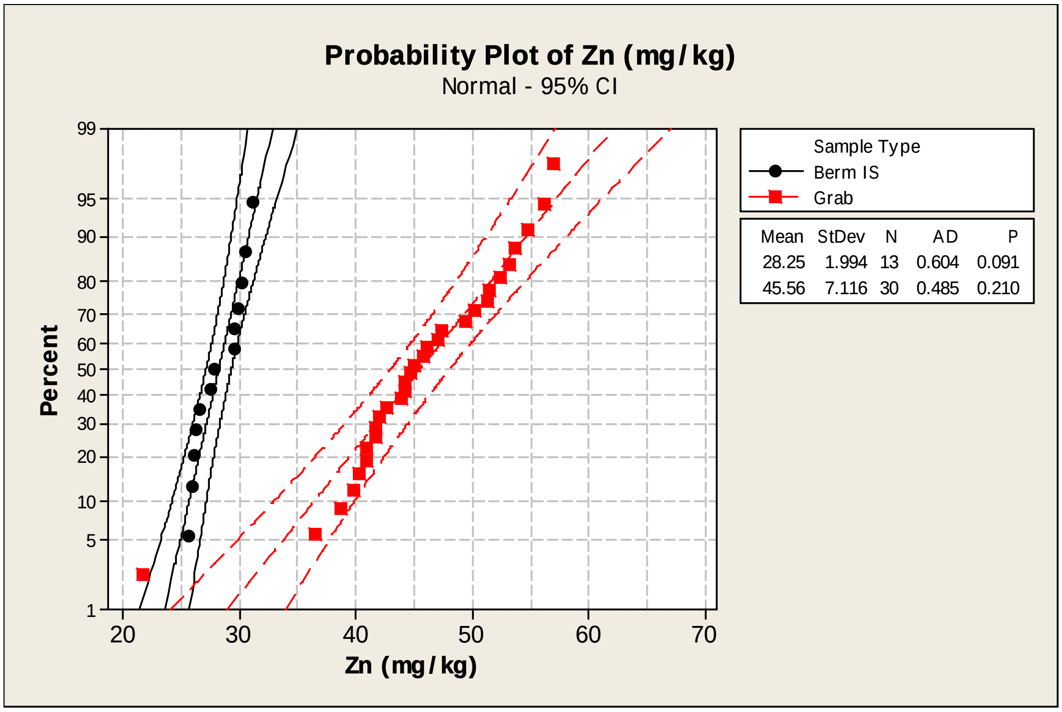
Appendix F-3: Normal probability plots for Pb, Cu, and Zn





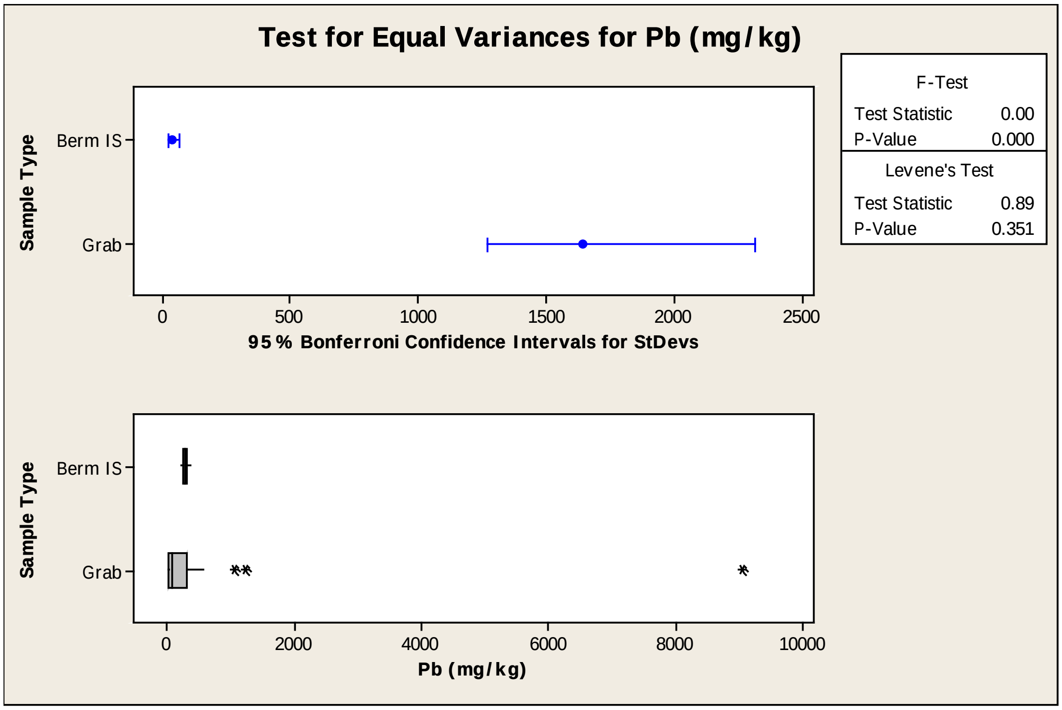

Probability Plot of Cu (mg/kg)
Normal - 95% CI
Percent
Cu (mg/kg)
Sample Type
Berm IS
Grab
Mean StDev N AD P
35.61 19.37 13 0.818 0.025
23.23 15.51 30 2.516 <0.005

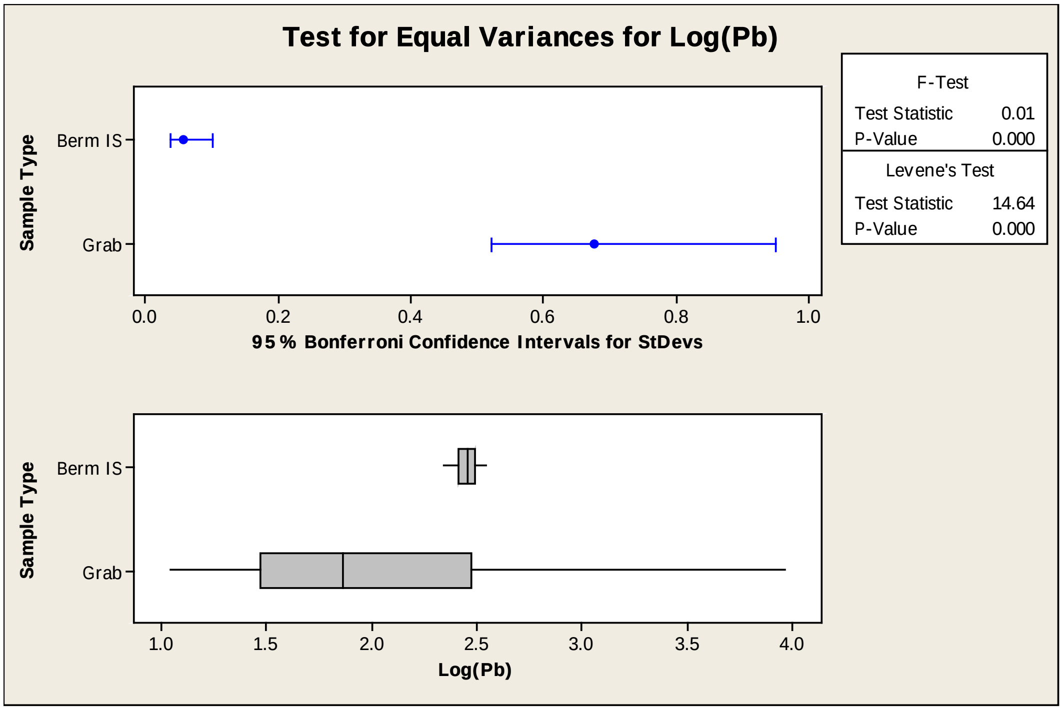

Probability Plot of Log(Cu)
Normal - 95% CI
Percent
Log(Cu)
Sample Type
Berm IS
Grab
Mean StDev N AD P
1.483 0.2614 13 0.699 0.051
1.296 0.2356 30 0.998 0.011

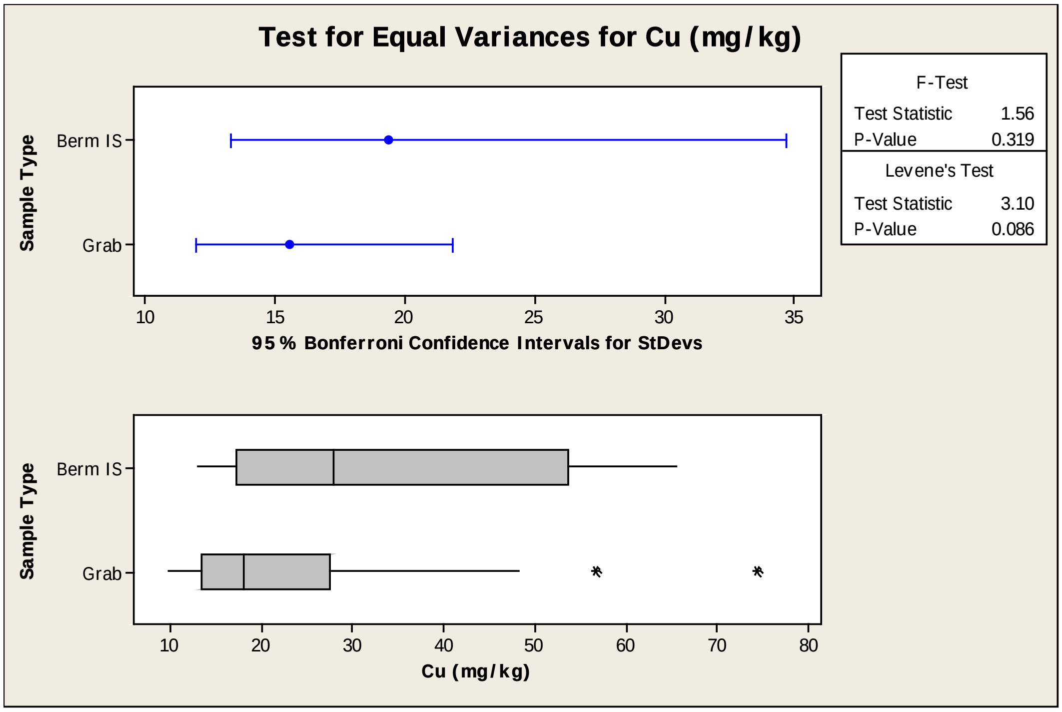


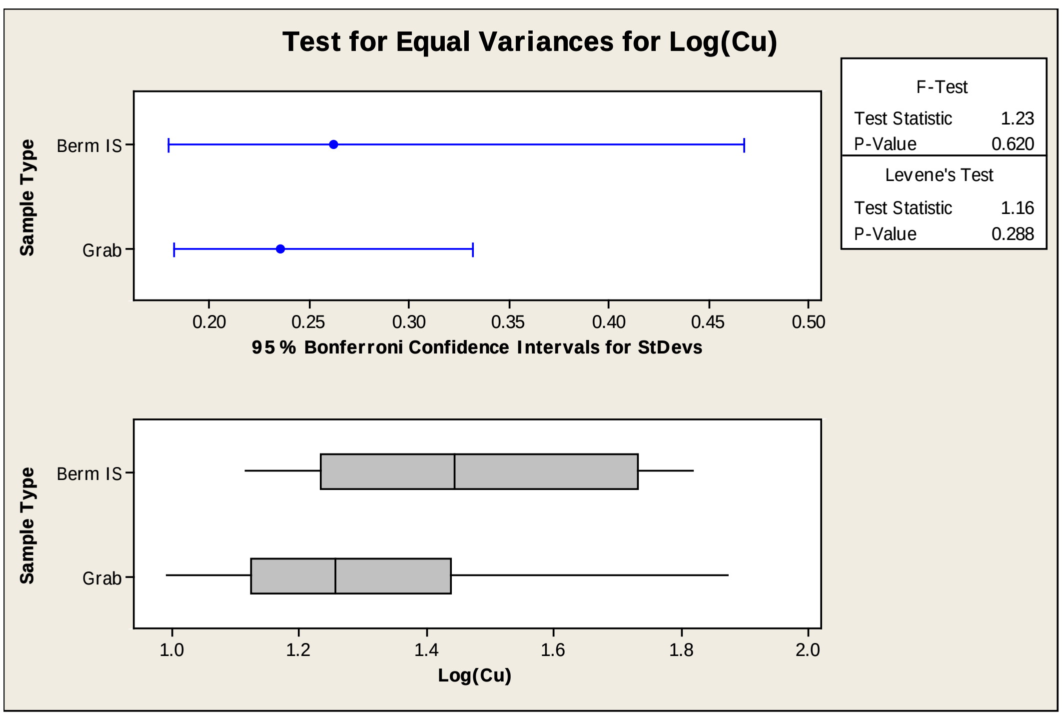
Probability Plot of Zn (mg/kg)
Normal - 95% CI
Percent
99
95
90
80
70
60
50
40
30
20
10
5
1
20
30
40
50
60
70
Zn (mg/kg)
Sample Type
Berm IS
Grab
Mean StDev N AD P
28.25 1.994 13 0.604 0.091
45.56 7.116 30 0.485 0.210

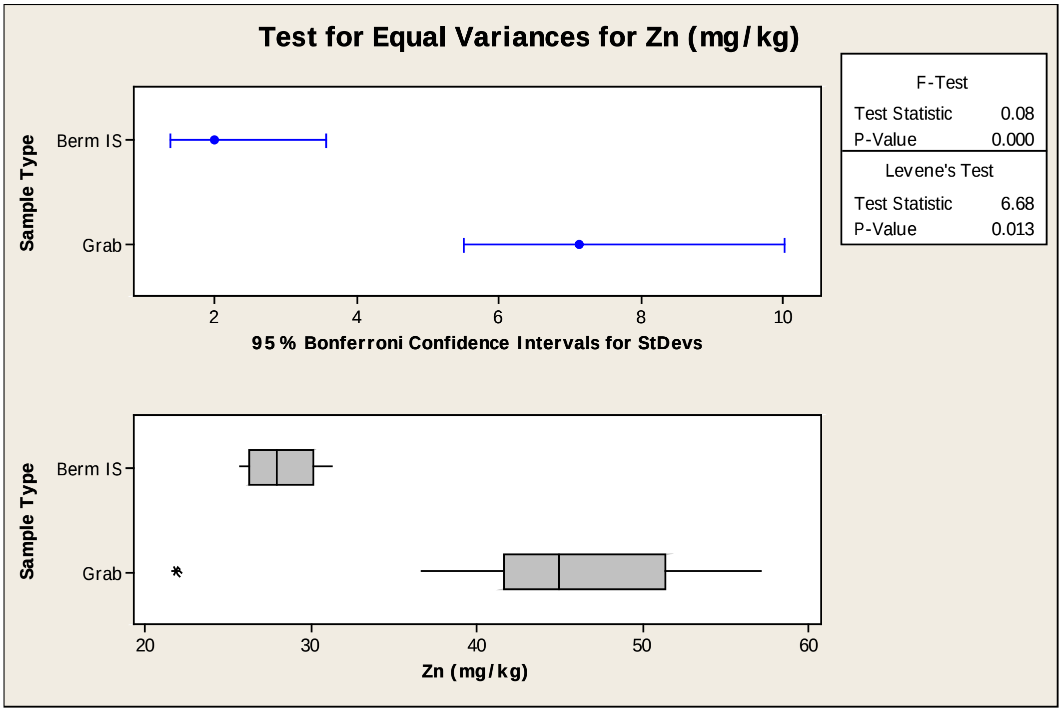
Appendix F-4: Tests for the variances for Pb, Cu, and Zn






Test for Equal Variances for Cu (mg/kg)
F-Test
Test Statistic 1.56
P-Value 0.319
Levene's Test
Test Statistic 3.10
P-Value 0.086
Sample Type
Berm IS
Grab
10 15 20 25 30 35
95% Bonferroni Confidence Intervals for StDevs
10 20 30 40 50 60 70 80
Cu (mg/kg)


Test for Equal Variances for Log(Cu)
F-Test
Test Statistic 1.23
P-Value 0.620
Levene's Test
Test Statistic 1.16
P-Value 0.288
Sample Type
Berm IS
Grab
0.20 0.25 0.30 0.35 0.40 0.45 0.50
95% Bonferroni Confidence Intervals for StDevs
1.0 1.2 1.4 1.6 1.8 2.0
Log(Cu)


Test for Equal Variances for Zn (mg/kg)
F-Test
Test Statistic 0.08
P-Value 0.000
Levene's Test
Test Statistic 6.68
P-Value 0.013
Sample Type
Berm IS
Grab
2
4
6
8
10
95% Bonferroni Confidence Intervals for StDevs
Sample Type
Berm IS
Grab
20
30
40
50
60
Zn (mg/kg)

Appendix F-5: Two-sample hypothesis tests to compare the mean and medians of the grab and ISM data

Kruskal-Wallis Test on Pb (mg/kg)

```
Sample Type   N  Median  Ave Rank      Z
Berm IS      13  284.00      29.2   2.46
Grab         30   73.50      18.9  -2.46
Overall      43              22.0
H = 6.05  DF = 1  P = 0.014
H = 6.05  DF = 1  P = 0.014  (adjusted for ties)
```

Two-sample T for Log(Pb)

```
Sample Type   N    Mean   StDev  SE Mean
Berm IS      13  2.4466  0.0560    0.016
Grab         30   1.978   0.676     0.12
Difference = mu (Berm IS) - mu (Grab)
Estimate for difference:  0.468
95% CI for difference:  (0.214, 0.723)
T-Test of difference = 0 (verse not =): T-Value = 3.77  P-Value = 0.001
DF = 29
```

Kruskal-Wallis Test on Cu (mg/kg)

```
Sample Type   N  Median  Ave Rank      Z
Berm IS      13   27.80      28.4   2.19
Grab         30   18.05      19.2  -2.19
Overall      43              22.0
H = 4.82  DF = 1  P = 0.028
```

Kruskal-Wallis Test on Zn (mg/kg)

```
Sample Type   N  Median  Ave Rank      Z
Berm IS      13   27.90       8.0  -4.81
Grab         30   44.90      28.1   4.81
Overall      43              22.0
H = 23.16  DF = 1  P = 0.000
H = 23.17  DF = 1  P = 0.000  (adjusted for ties)
```

Two-sample T for Zn (mg/kg)

```
Sample Type   N   Mean  StDev  SE Mean
Berm IS      13  28.25   1.99     0.55
Grab         30  45.56   7.12      1.3
Difference = mu (Berm IS) - mu (Grab)
Estimate for difference:  -17.31
95% CI for difference:  (-20.17, -14.45)
T-Test of difference = 0 (verse not =): T-Value = -12.26  P-Value = 0.000
DF = 37
```

Appendix G: Statistical Summary of Fort Eustis Data

Introduction

Descriptive statistics are presented below for the metals Pb, Cu, and Zn for Fort Eustis data sets:

Variable	Sample Type - Location	N	Mean	StDev	Median	IQR
Pb (mg/kg)	ISM Entire Berm	3	495.7	94.7	509.0	188.0
	ISM Middle Berm	3	209.0	50.3	183.0	90.0
	ISM Rt Side Berm	14	932.4	275.5	933.5	360.0
	ISM Rt Side Berm - Large	6	1090.5	134.0	1140.0	249.8
	Left Grab	9	37.32	16.80	30.90	32.95
	Middle Grab	12	162.6	147.2	127.0	200.6
	Rt Grab	12	1002	2472	212	312
	Grab Entire Berm	33	434	1517	94	178
Cu (mg/kg)	ISM Entire Berm	3	51.20	15.82	44.90	29.70
	ISM Middle Berm	3	24.000	1.058	24.400	2.000
	ISM Rt Side Berm	14	114.3	50.3	100.5	47.7
	ISM Rt Side Berm - Large	6	119.5	24.9	113.0	33.7
	Left Grab	9	7.974	0.601	8.070	1.100
	Middle Grab	12	19.54	11.13	14.95	17.52
	Rt Grab	12	93.5	209.3	28.1	46.2
	Grab Entire Berm	33	43.3	128.9	13.2	23.3
Zn (mg/kg)	ISM Entire Berm	3	34.533	0.208	34.600	0.400
	ISM Middle Berm	3	33.400	0.346	33.600	0.600
	ISM Rt Side Berm	14	34.421	1.296	34.300	2.125
	ISM Rt Side Berm - Large	6	34.52	2.89	33.95	3.70
	Left Grab	9	27.98	3.79	28.00	6.60
	Middle Grab	12	28.53	6.91	25.75	4.05
	Rt Grab	12	29.18	7.94	27.25	12.98
	Grab Entire Berm	33	28.62	6.47	27.60	6.60

Figure G1 illustrates a berm at Fort Eustis that was divided into a set of 33 cells prior to sampling. The data set “ISM Entire Berm” consists of n = 3 incremental samples of 99 increments each (wet mass about 1 kg) collected over the entire berm. The data set “ISM Rt Side Berm” consists of n = 14 incremental samples of 48 increments each (wet masses of 400–500 kg) collected from only the right side of the same berm (cells 1–4, 12–15, and 23–26). The data set “ISM Rt Side Berm—Large” consists of n = 6 incremental samples from the same location (i.e., the right side of the berm) that were collected using a larger diameter coring tool; these incremental samples had wet masses of about 1.4–1.5 kg.

11	10	9	8	7	6	5	4	3	2	1
22	21	20	19	18	17	16	15	14	13	12
33	32	31	30	29	28	27	26	25	24	23

Figure G1. Grid Layout for Fort Eustis berm.

The data set "Grab Entire Berm" consists of n = 33 grab samples collected over the entire berm (one from each cell shown in Figure G1). The data sets "Left Grab" (n = 9), "Rt Grab" (n = 12), and "Middle Grab" (n = 12) are subsets of the data set "Grab Entire Berm" (n = 33). "Rt Grab" consists of n = 12 grab samples from the right side of the berm (cells 1–4, 12–15, and 23–26). "Middle Grab" consists of n = 12 grab samples from the middle of the berm (cells 5–8, 15–19, and 27–30). "Left Grab" consists of the grab samples from the remaining cells on the left side of the berm (cells 9–11, 20–22, and 31–33).

Owing to the small sample sizes, reliable statistical comparisons could not be done for most of the data sets; the sample sizes were adequate primarily for the "ISM Rt Side Berm" (n =14) and "Rt Grab" (n = 12) data sets.

Discussion and conclusions

1. The ISM approach tends to normalize distributions of measured metal concentrations owing to contamination from small arms. The normal probability plots in Appendix G-2 show that the "Grab Entire Berm" data sets for Pb, Cu, and Zn are not normal; the boxplots in Appendix G-1 suggest the distributions are positively skewed. The Pb, Cu, and Zn "ISM Entire Berm" data sets are consistent with normal distributions; but the sample sizes are too small to do reliable statistical tests for normality.

2. The normal probability plots were generated for the Pb, Cu, and Zn "ISM Rt Side Berm," "ISM Rt Side Berm—Larger Mass," and "Rt Grab" data sets (Appendix B). The "Rt Grab" Pb data set is not normal; both the Pb "ISM Rt Side Berm" and "ISM Rt Side Berm—Larger Mass" data sets are consistent with normal distributions. The "Rt Grab" Cu data set is not normal nor lognormal; the Cu "ISM Rt Side Berm" is approximately lognormal, and the "ISM Rt Side Berm—Larger Mass" data set is normal. The Zn "ISM Rt Side Berm," "ISM Rt Side Berm—Larger Mass," and "Rt Grab" data sets are all consistent with normal distributions.

3. The grab results exhibit larger variability than the ISM results overall. Unlike the ISM data sets, the boxplots indicate that the grab results exhibit large outliers (Appendix G-2). Significant differences in the ISM and grab variances at the 95% level of confidence were detected for Pb and Cu, using Levene's test, when logarithm transformations were done for the "ISM Rt Side Berm," "ISM Rt Side Berm—Larger Mass," and "Rt Grab" data sets (Appendix G-3). Levene's test also identified significant differences in the variances for the Zn "ISM Rt Side Berm," "ISM Rt Side Berm—Larger Mass," and "Rt Grab" data sets. The grab variances are larger than the corresponding ISM variances. However (contrary to expectations), there was insufficient evidence to conclude that the larger-mass incremental samples collected from the right side of the berm significantly improved the quality of the data (e.g., variability was not significantly reduced).

4. The ISM data sets tended to result in larger average concentrations. The Kruskal-Wallis test was used to compare the average (median) Pb, Cu, and Zn concentrations for the "ISM Rt Side Berm," "ISM Rt Side Berm—Larger Mass," and "Rt Grab" (Appendix G-4). Significant differences were detected for Pb and Cu at the 95% level of confidence. A significant difference was detected at about the 94% level of confidence for Zn. Qualitative evaluations of the boxplots for the Pb, Cu, and Zn "Middle Grab" and "ISM Middle Berm" data sets also support the conclusion that incremental sampling tends to result in larger average concentrations. As shown in the boxplots, the incremental sample medians are consistently larger than the grab sample medians for Pb, Cu, and Zn.

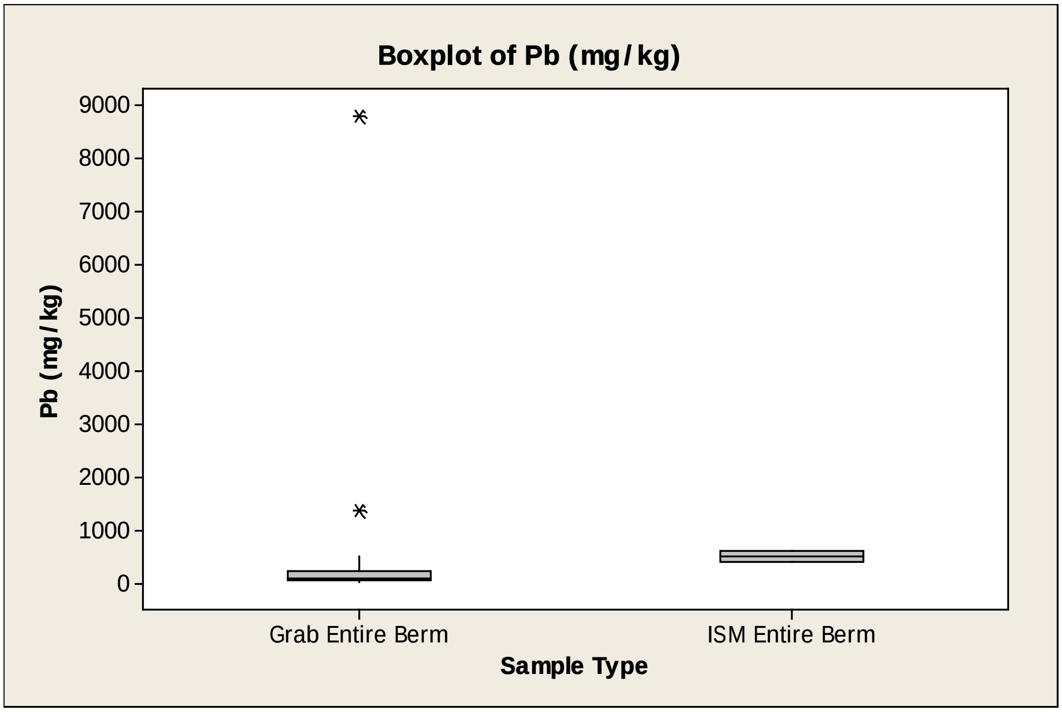
5. The berm possesses long-range spatial heterogeneity. As is evident from a qualitative evaluation of the boxplots of the ISM results in Appendix G-1.4, the right portion of the berm possess larger metal concentrations than the middle portion of the berm. With the possible exception of Zn, the median metal concentrations in the middle of the berm are smaller than the concentrations in the right side of the berm.

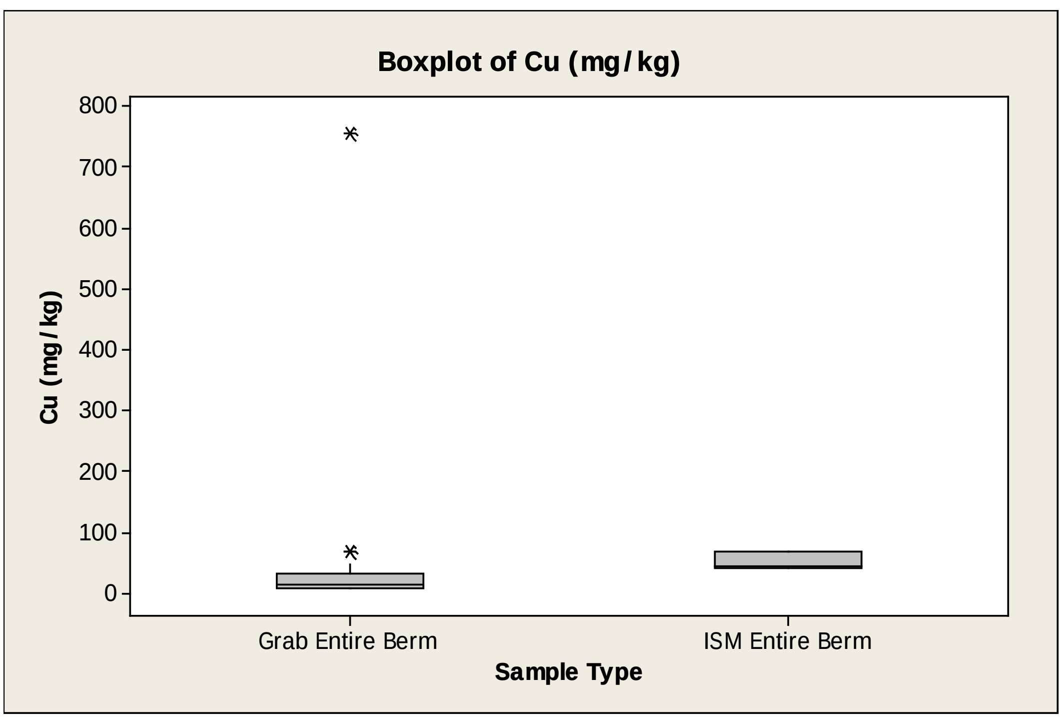
6. As the Sb data set contained non-detects and the sample size was relatively small, only limited statistical evaluations was done for using the Sb data sets "ISM Rt Side Berm," "ISM Rt Side Berm—Larger Mass," and "Rt Grab." The observations for the Sb ISM and grab were relatively consistent with those for Pb, Zn, and Cu. In particular, as shown in the boxplot in Appendix G-5, incremental sampling tends to normalize data. The Sb grab

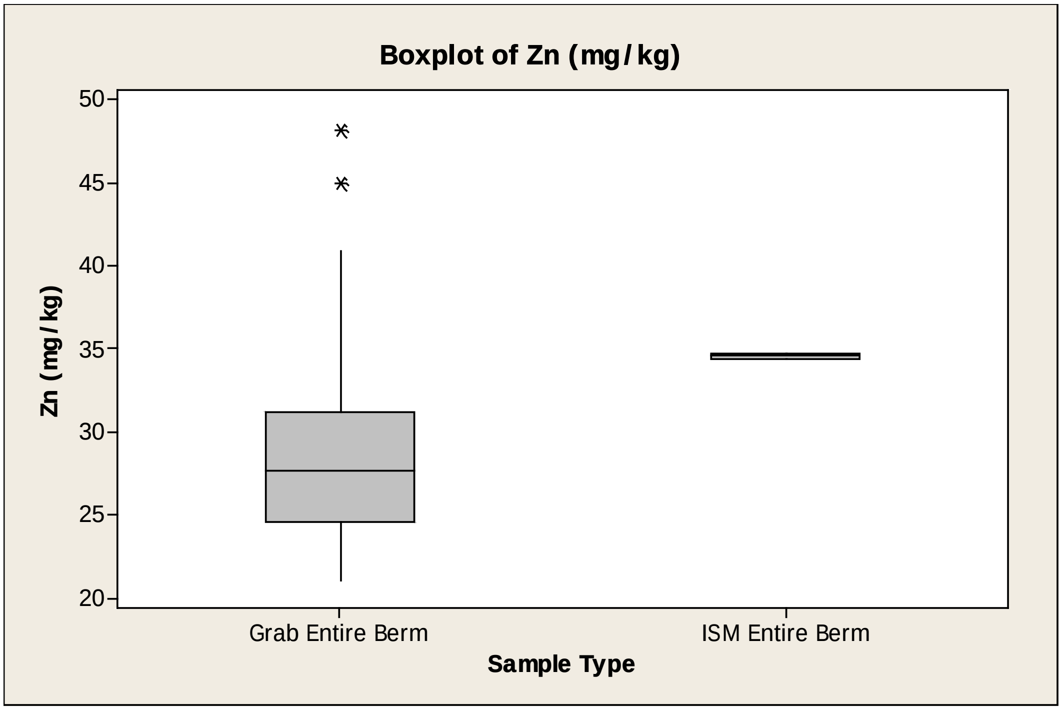
samples from the right side of the berm exhibit a positively skewed distribution with a large outlier. About 60% of the Sb grab samples are non-detects; the detected concentrations are consistent with a lognormal distribution. In contrast, the ISM Sb data sets consist entirely of detected concentrations that are normally distributed. The ISM results appear to exhibit less variability (e.g., as the range of concentrations and sample standard deviations are smaller). The sample means of the grab and ISM results are similar, but the ISM sample medians (6–9 mg/kg) are much larger than the grab sample median (less than 0.02 mg/kg). The medians of the Grab and ISM data sets are significantly different with over 95% confidence by the Mann-Whitney test.

Appendix G-1: Boxplots

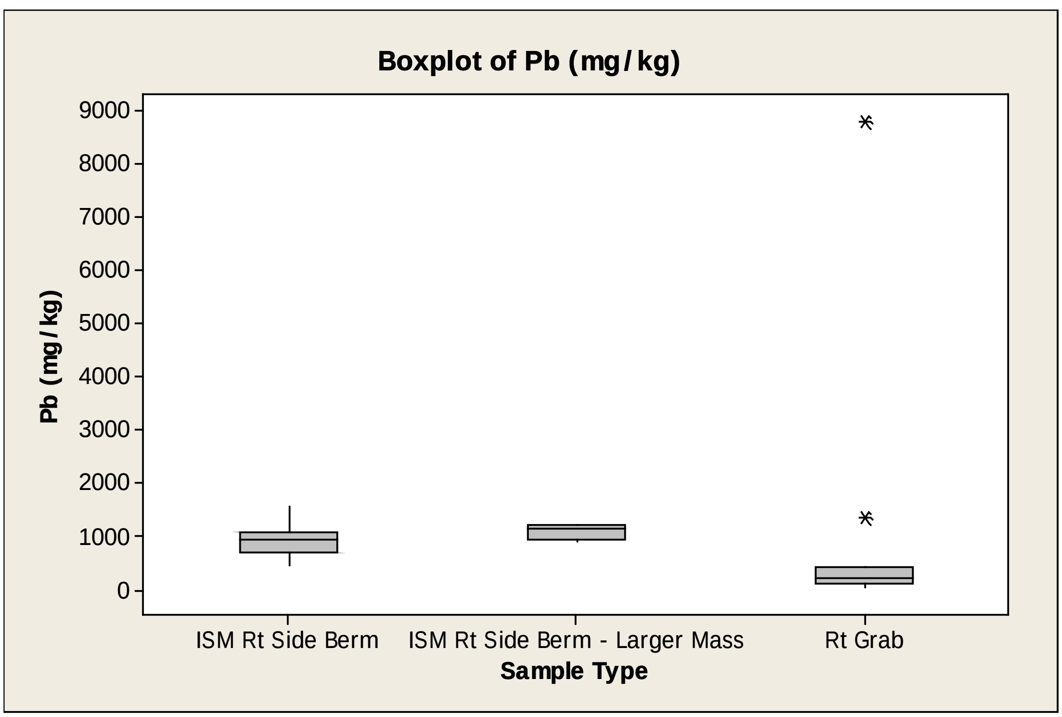
G-1.1. Boxplots for “Grab Entire Berm” and “ISM Entire Berm”

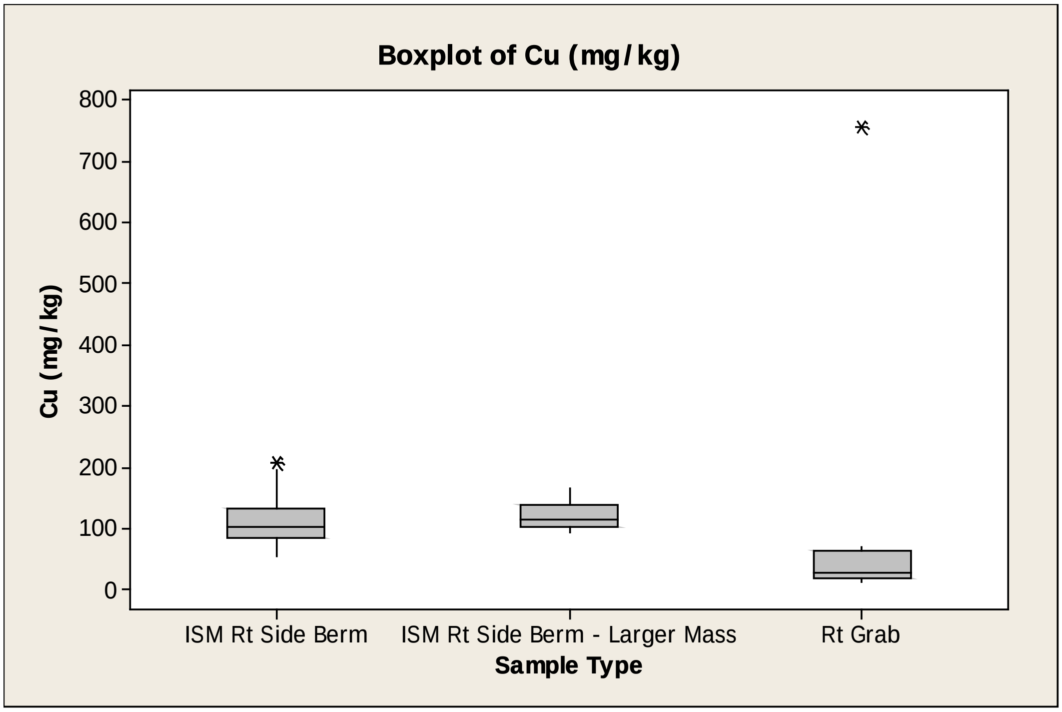


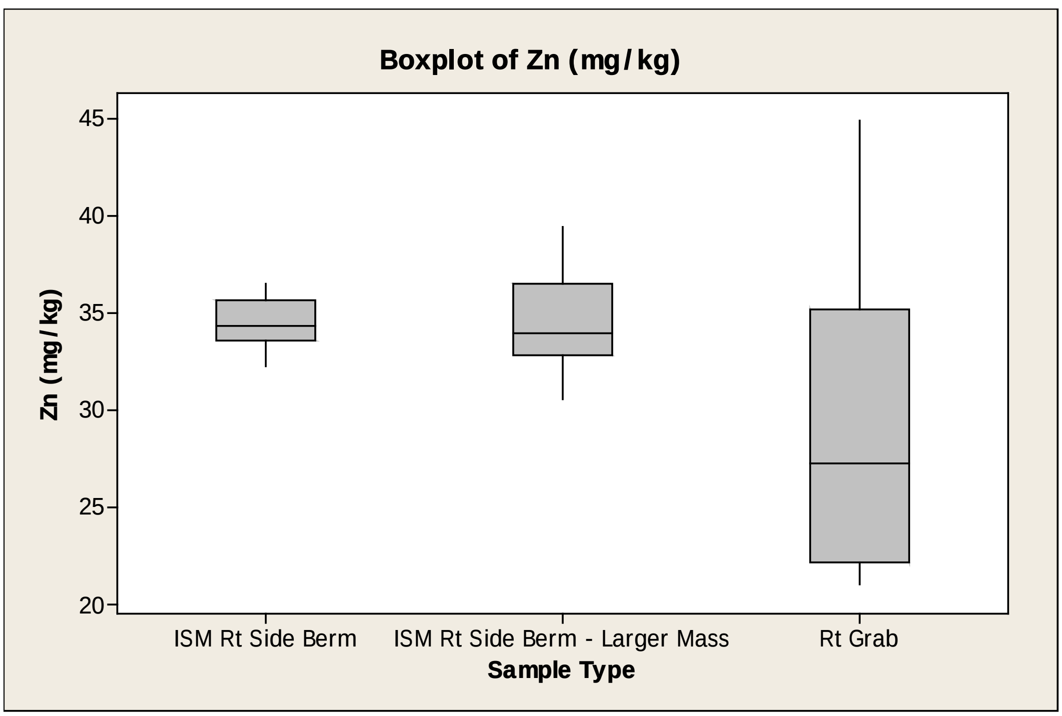




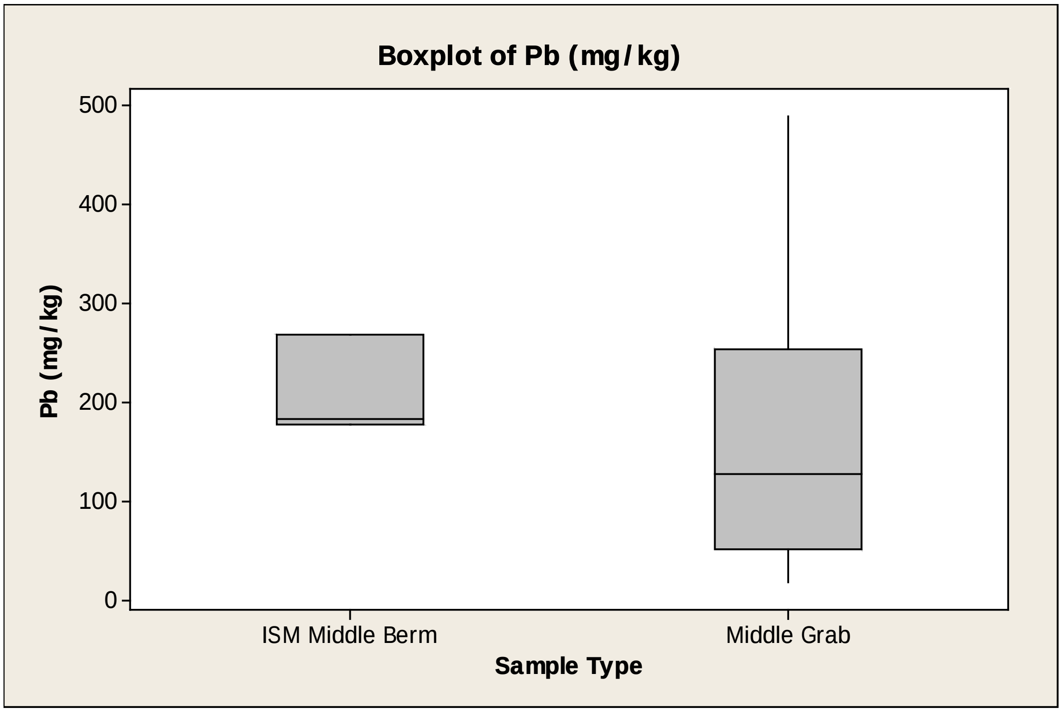
G-1.2. Boxplots of "ISM Rt Side Berm," "ISM Rt Side Berm—Larger Mass," and "Rt Grab"

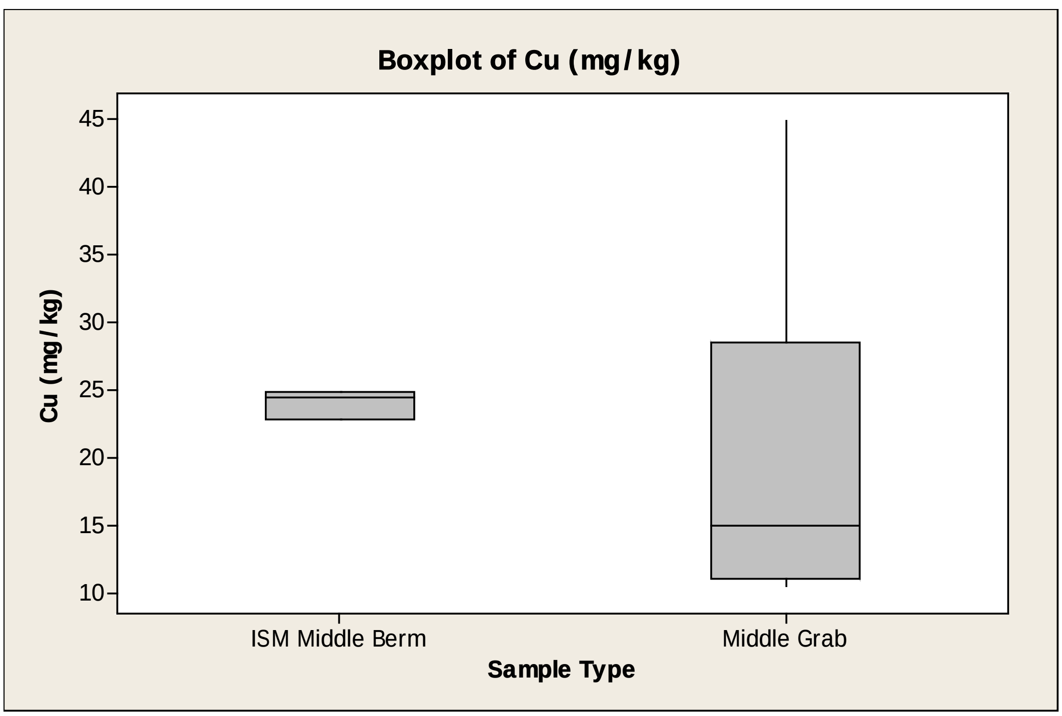


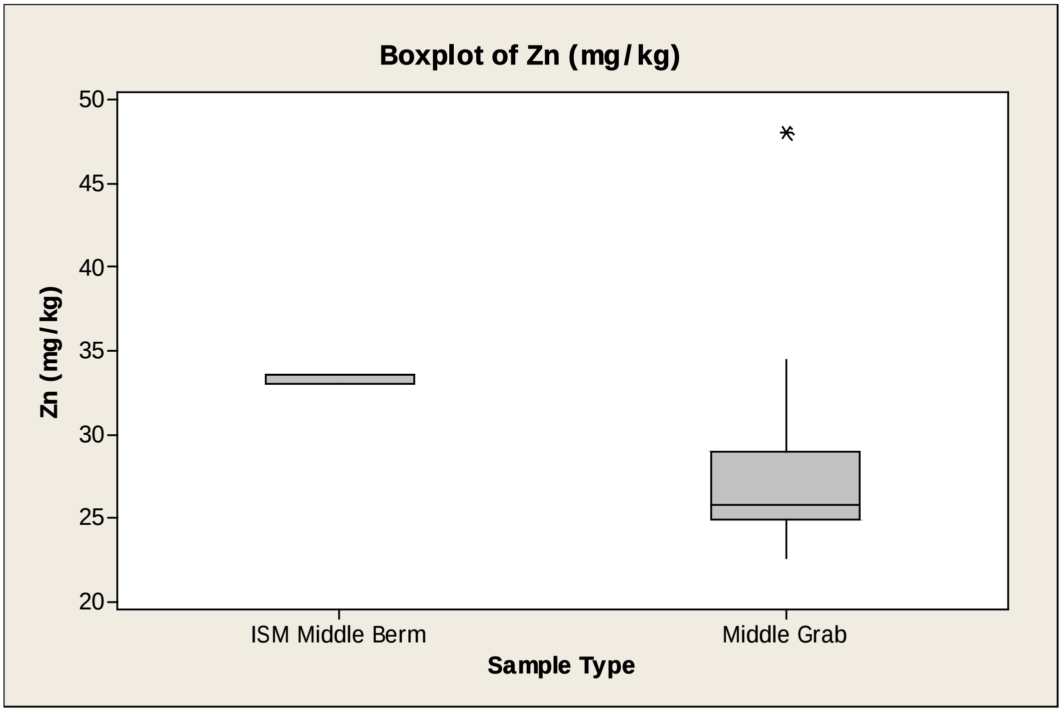

Boxplot of Cu (mg/kg)
Cu (mg/kg)
800
700
600
500
400
300
200
100
0
ISM Rt Side Berm
ISM Rt Side Berm - Larger Mass
Rt Grab
Sample Type


Boxplot of Zn (mg/kg)
Zn (mg/kg)
45
40
35
30
25
20
ISM Rt Side Berm
ISM Rt Side Berm - Larger Mass
Rt Grab
Sample Type

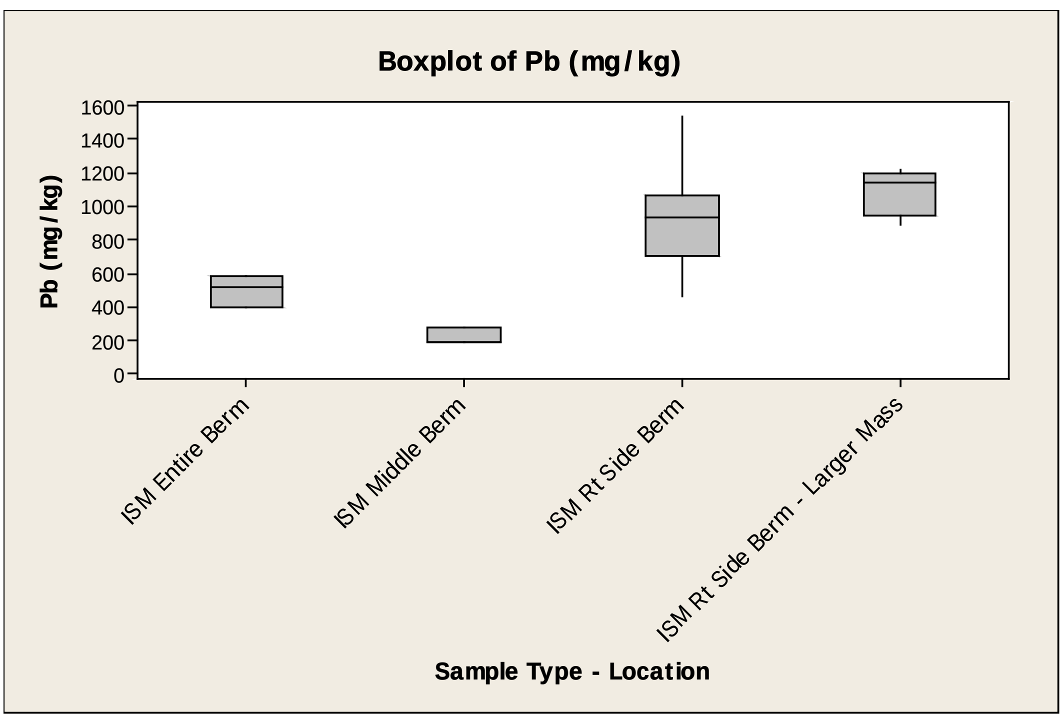
G-1.3. Boxplots of "Middle Grab" and "ISM Middle Berm"

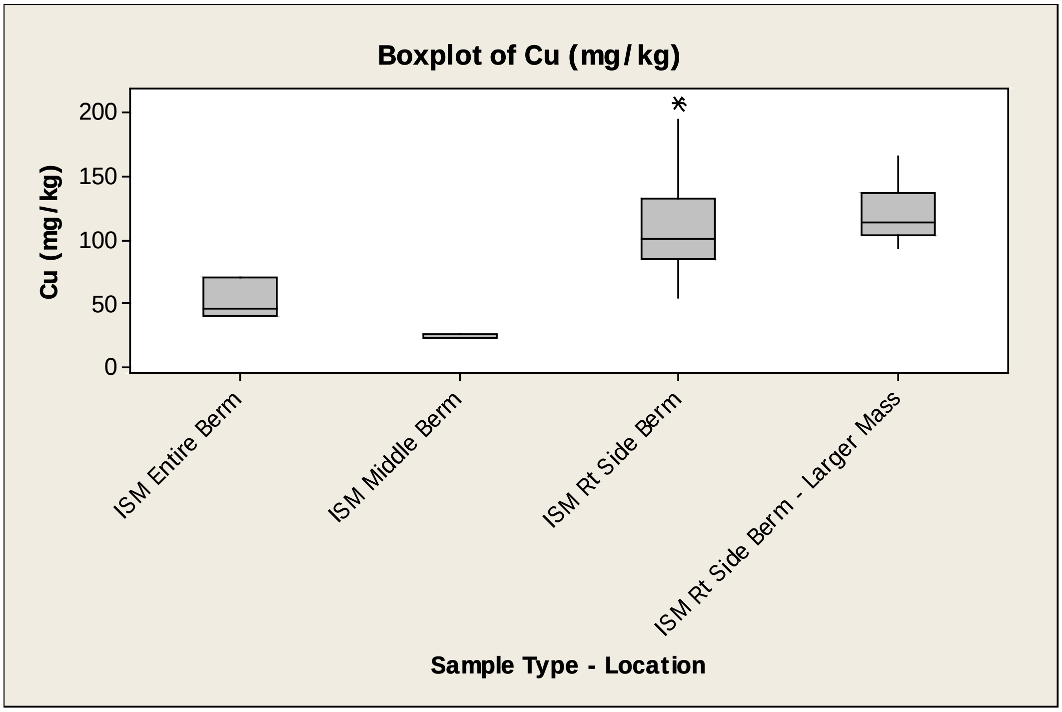


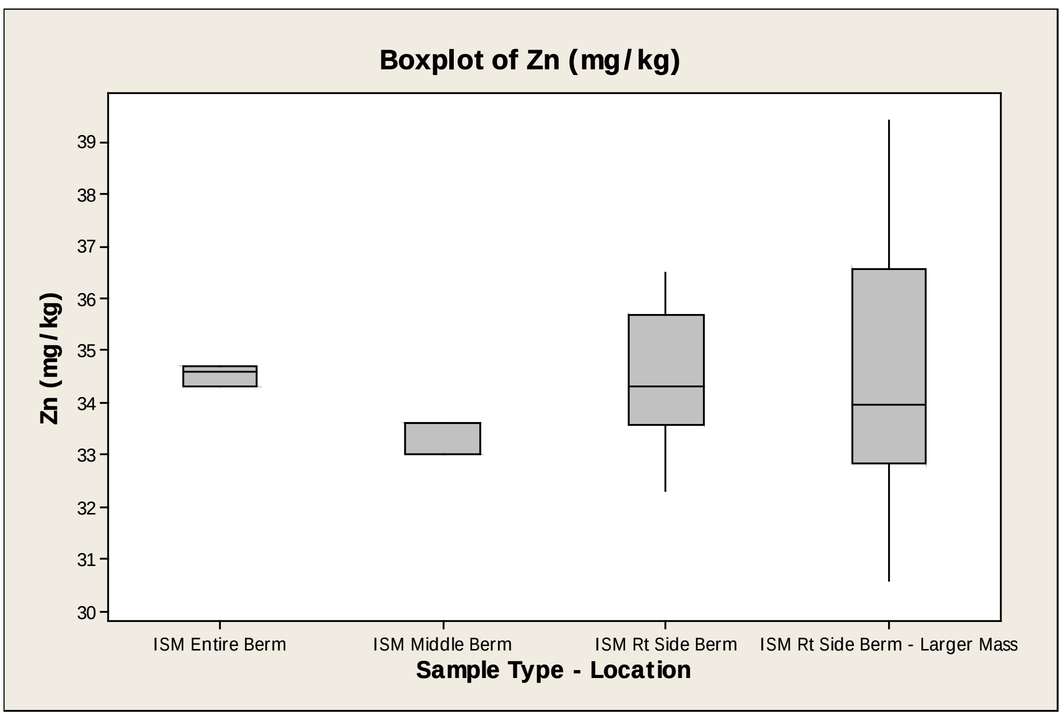




G-1.4. Boxplots of all ISM results

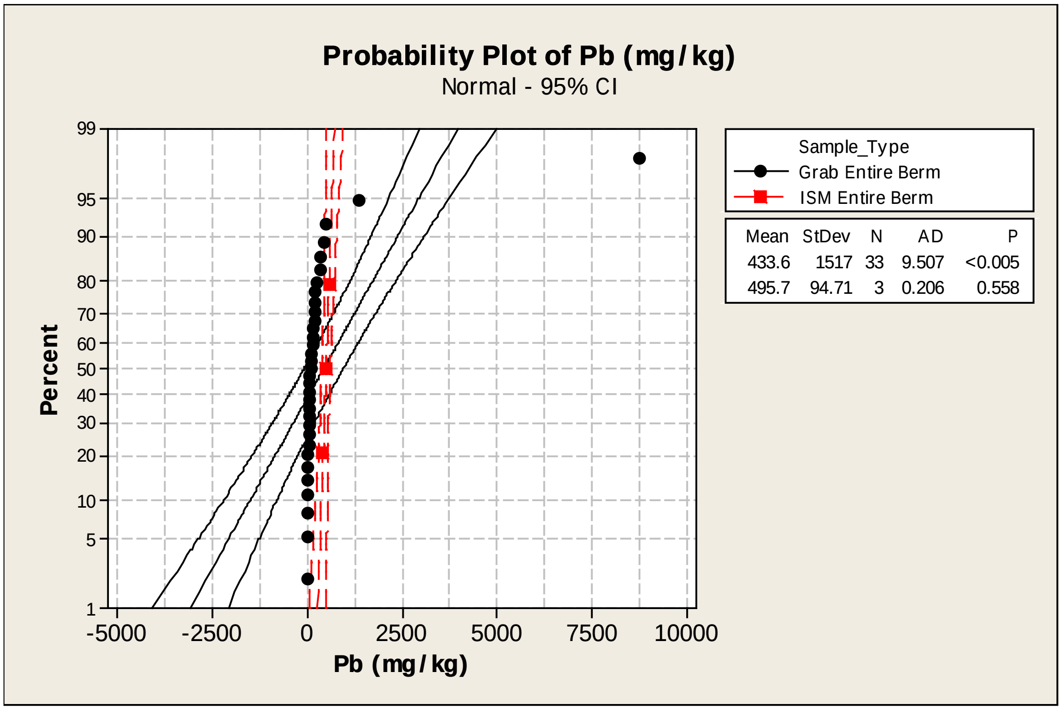


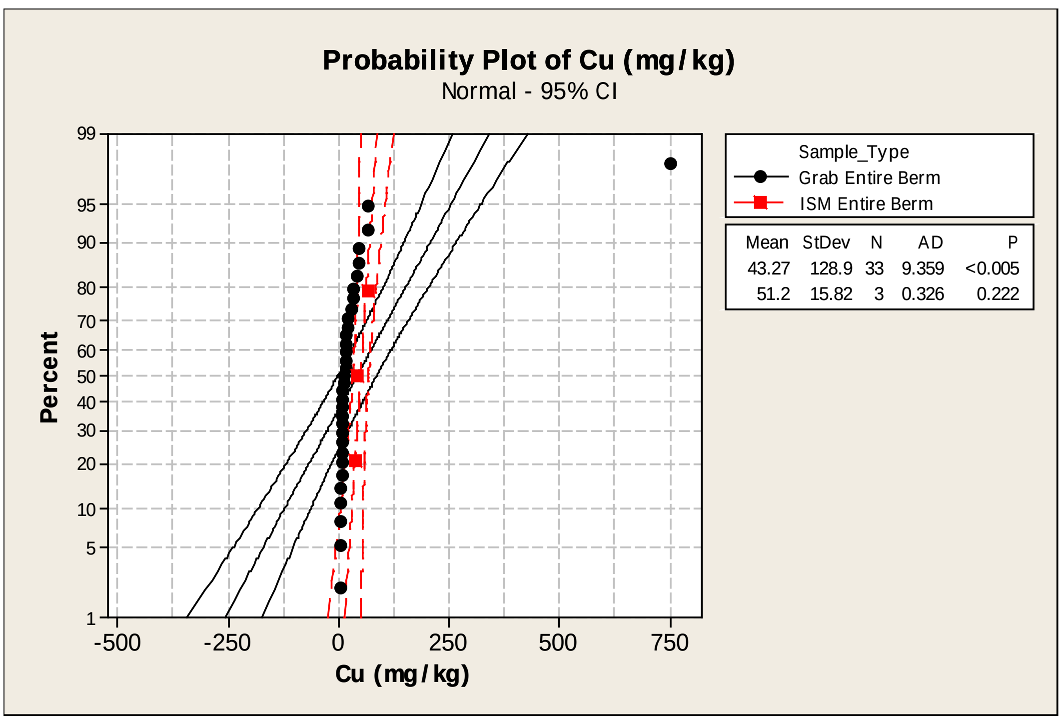

Boxplot of Cu (mg/kg)
Cu (mg/kg)
200
150
100
50
0
ISM Entire Berm
ISM Middle Berm
ISM Rt Side Berm
ISM Rt Side Berm - Larger Mass
Sample Type - Location

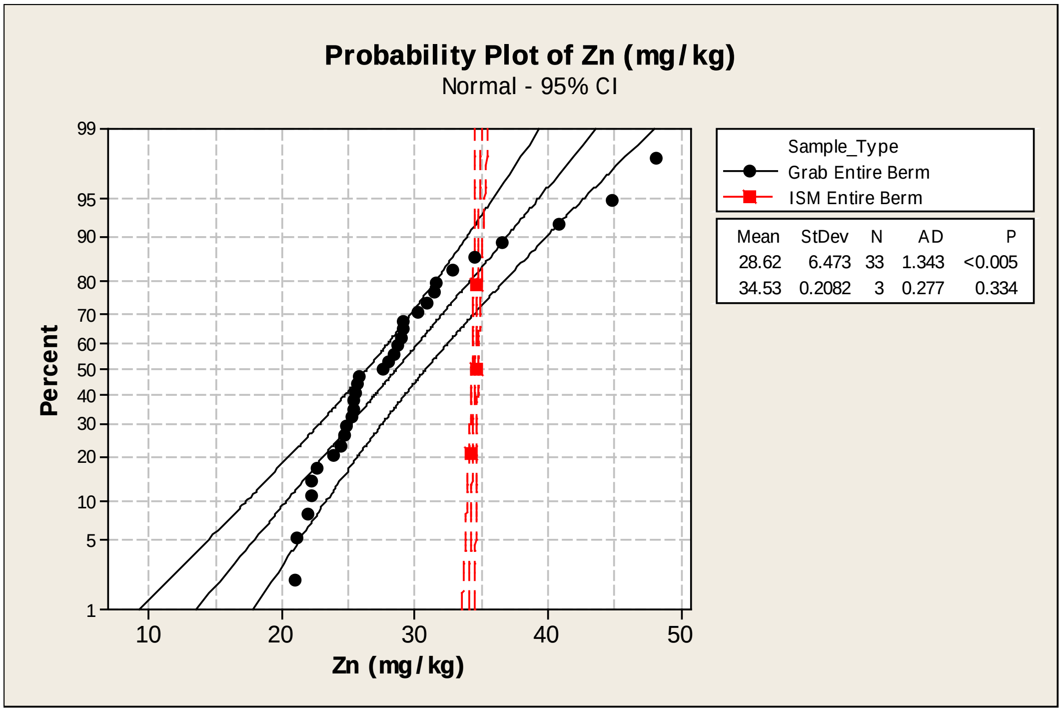

Boxplot of Zn (mg/kg)
Zn (mg/kg)
39
38
37
36
35
34
33
32
31
30
ISM Entire Berm
ISM Middle Berm
ISM Rt Side Berm
ISM Rt Side Berm - Larger Mass
Sample Type - Location

Appendix G-2: Normal probability plots

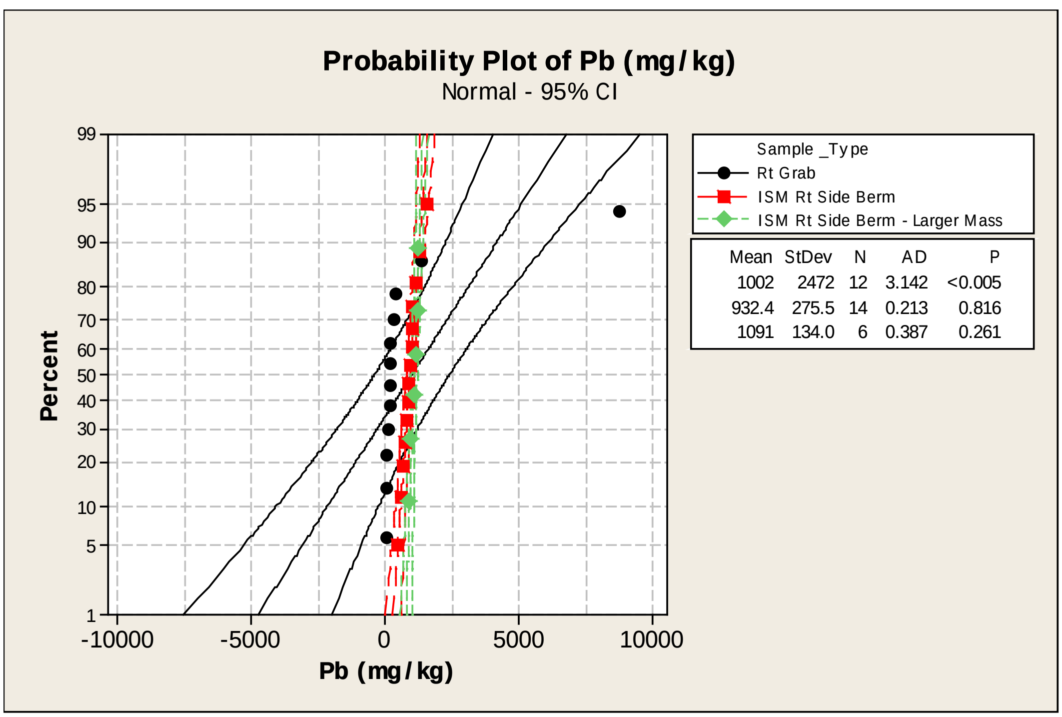
G-2.1. "Grab Entire Berm" and "ISM Entire Berm"

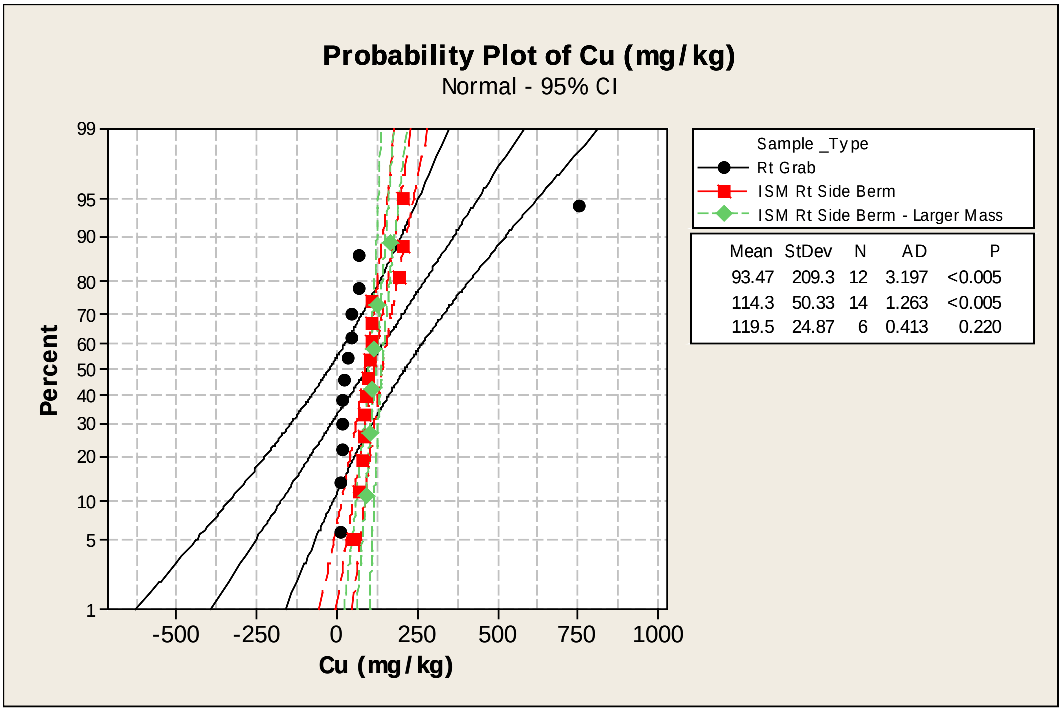


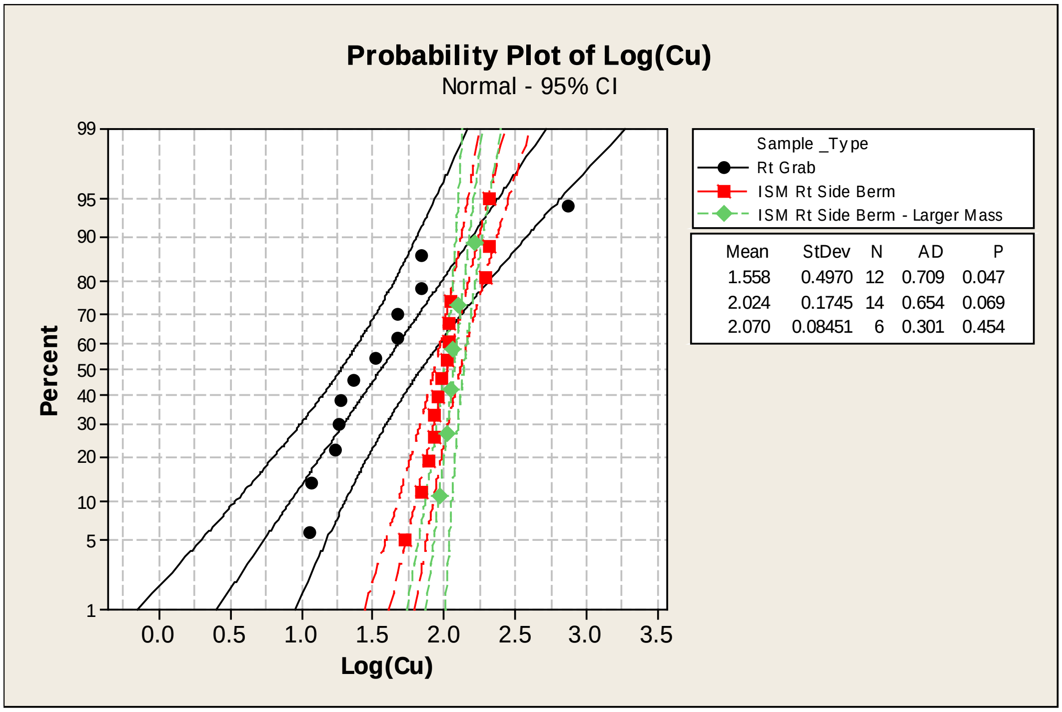


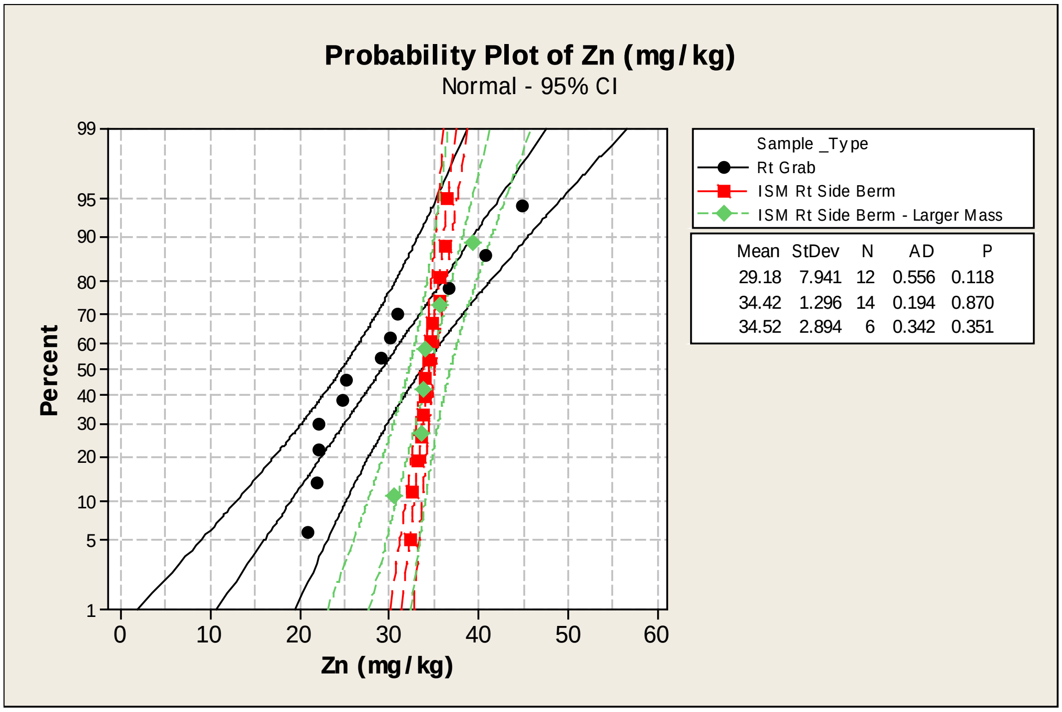


G-2.2. Normal probability plots for "ISM Rt Side Berm," "ISM Rt Side Berm—Larger Mass," and "Rt Grab"



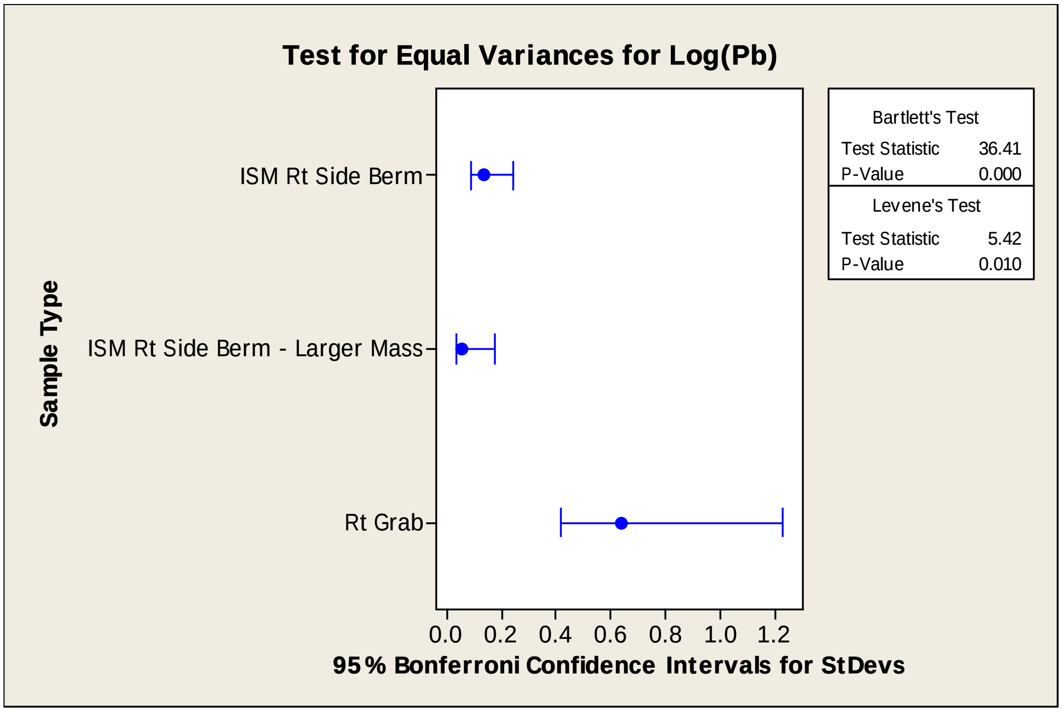

Probability Plot of Cu (mg/kg)
Normal - 95% CI
Percent
Cu (mg/kg)
Sample_Type
Rt Grab
ISM Rt Side Berm
ISM Rt Side Berm - Larger Mass
Mean StDev N AD P
93.47 209.3 12 3.197 <0.005
114.3 50.33 14 1.263 <0.005
119.5 24.87 6 0.413 0.220

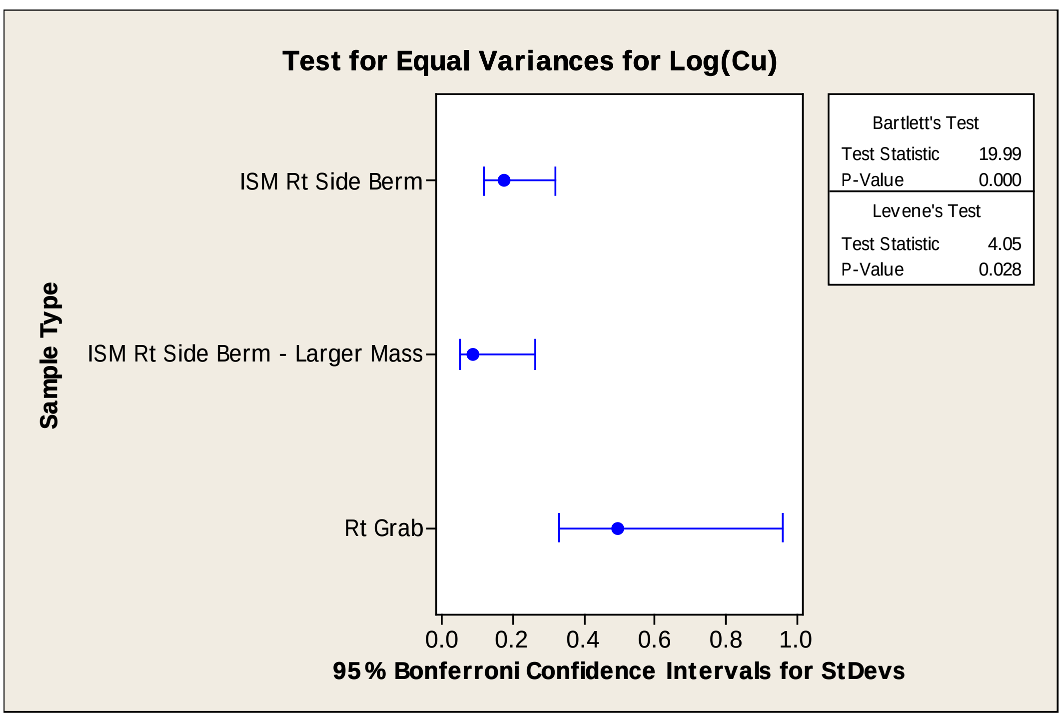

Probability Plot of Log(Cu)
Normal - 95% CI
Percent
Log(Cu)
Sample_Type
Rt Grab
ISM Rt Side Berm
ISM Rt Side Berm - Larger Mass
Mean StDev N AD P
1.558 0.4970 12 0.709 0.047
2.024 0.1745 14 0.654 0.069
2.070 0.08451 6 0.301 0.454

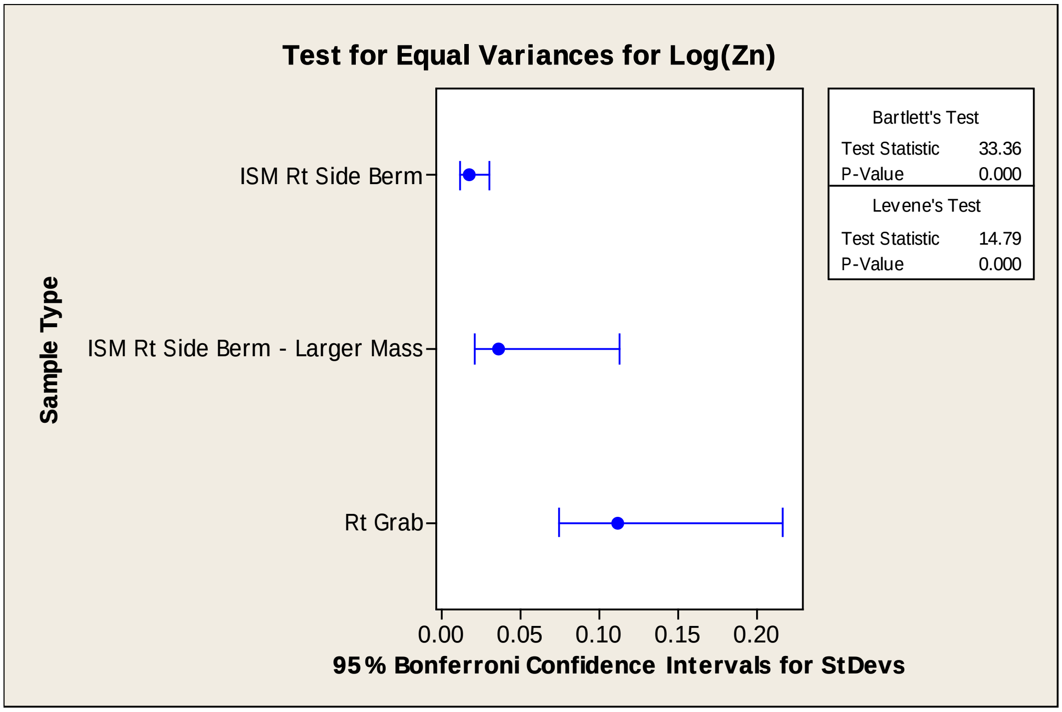


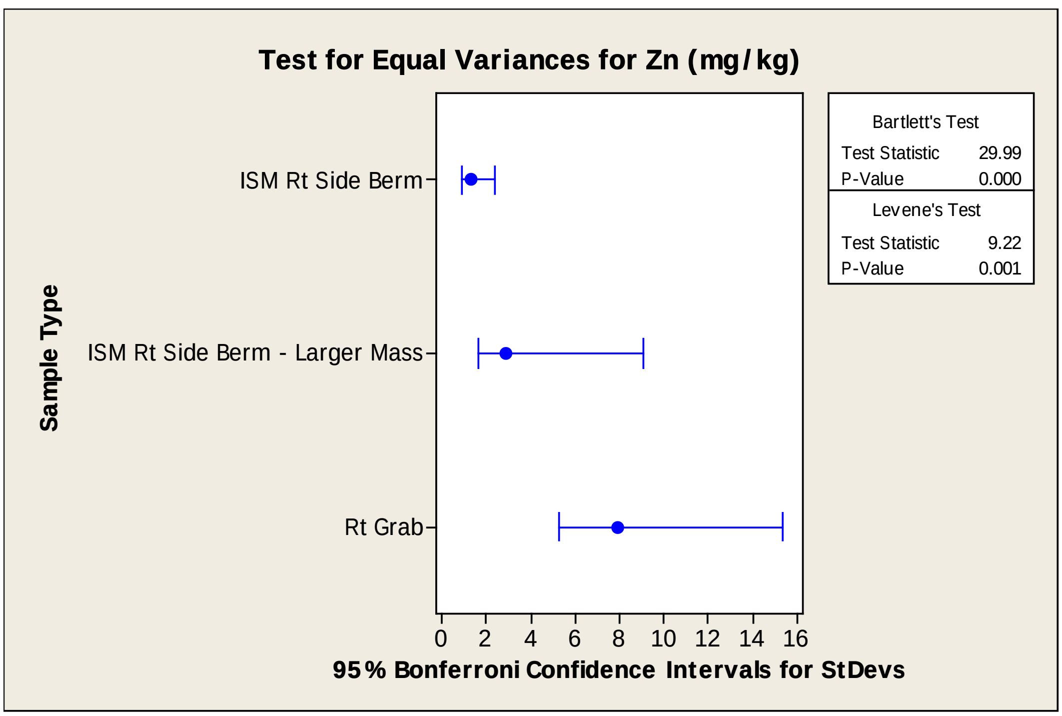
Probability Plot of Zn (mg/kg)
Normal - 95% CI
Percent
99
95
90
80
70
60
50
40
30
20
10
5
1
0
10
20
30
40
50
60
Zn (mg/kg)
Sample _Type
Rt Grab
ISM Rt Side Berm
ISM Rt Side Berm - Larger Mass
Mean StDev N AD P
29.18 7.941 12 0.556 0.118
34.42 1.296 14 0.194 0.870
34.52 2.894 6 0.342 0.351

Appendix G-3: Levene's test for data sets "ISM Rt Side Berm," "ISM Rt Side Berm—Larger Mass," and "Rt Grab"






Test for Equal Variances for Log(Zn)
Sample Type
ISM Rt Side Berm
ISM Rt Side Berm - Larger Mass
Rt Grab
0.00
0.05
0.10
0.15
0.20
95% Bonferroni Confidence Intervals for StDevs
Bartlett's Test
Test Statistic 33.36
P-Value 0.000
Levene's Test
Test Statistic 14.79
P-Value 0.000


Test for Equal Variances for Zn (mg/kg)
Sample Type
ISM Rt Side Berm
ISM Rt Side Berm - Larger Mass
Rt Grab
0
2
4
6
8
10
12
14
16
95% Bonferroni Confidence Intervals for StDevs
Bartlett's Test
Test Statistic 29.99
P-Value 0.000
Levene's Test
Test Statistic 9.22
P-Value 0.001

Appendix G-4: Kruskal-Wallis test for data sets "ISM Rt Side Berm," "ISM Rt Side Berm—Larger Mass," and "Rt Grab"

Kruskal-Wallis Test on Pb (mg/kg)

Sample Type	N	Median	Ave Rank	Z
ISM Rt Side Berm	14	933.5	19.4	1.52
ISM Rt Side Berm—Larger Mass	6	1140.0	23.3	1.98
Rt Grab	12	211.5	9.8	-3.15
Overall	32		16.5	

Kruskal-Wallis Test on Cu (mg/kg)

Sample Type	N	Median	Ave Rank	Z
ISM Rt Side Berm	14	100.50	20.2	1.98
ISM Rt Side Berm—Larger Mass	6	113.00	24.2	2.22
Rt Grab	12	28.15	8.3	-3.81
Overall	32		16.5	

H = 15.30 DF = 2 P = 0.000
H = 15.30 DF = 2 P = 0.000 (adjusted for ties)

Kruskal-Wallis Test on Zn (mg/kg)

Sample Type - Location	N	Median	Ave Rank	Z
ISM Rt Side Berm	14	34.30	19.8	1.75
ISM Rt Side Berm—Larger Mass	6	33.95	18.8	0.68
Rt Grab	12	27.25	11.5	-2.34
Overall	32		16.5	

H = 5.50 DF = 2 P = 0.064
H = 5.50 DF = 2 P = 0.064 (adjusted for ties)

Appendix G-5: Antimony

ROS Estimated Statistics for Sb (mg/kg)—Grab samples from Right Side of Berm *

Variable	N	Mean	SE Mean	StDev	Minimum	Q1	Median	Q3	Maximum
ESTIMATE	12	7.28	5.75	19.94	0.00	0.00	0.01	3.43	69.60

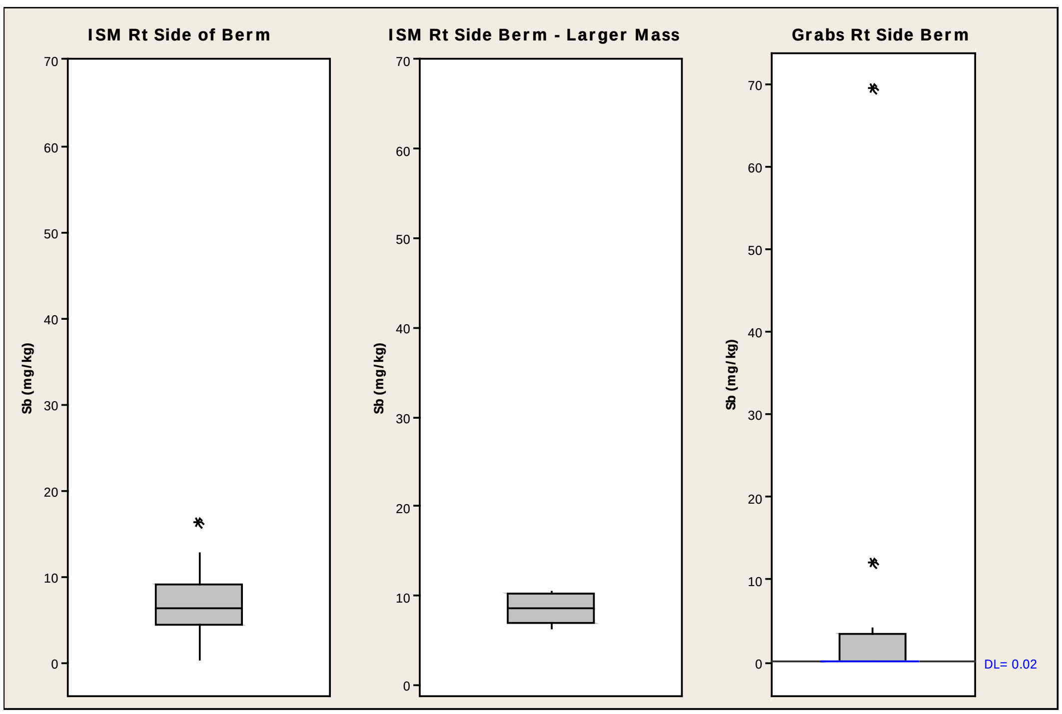
* The descriptive statistics and the censored plots were generated using the Minitab macro “CROS,” which uses log regression on order statistics.

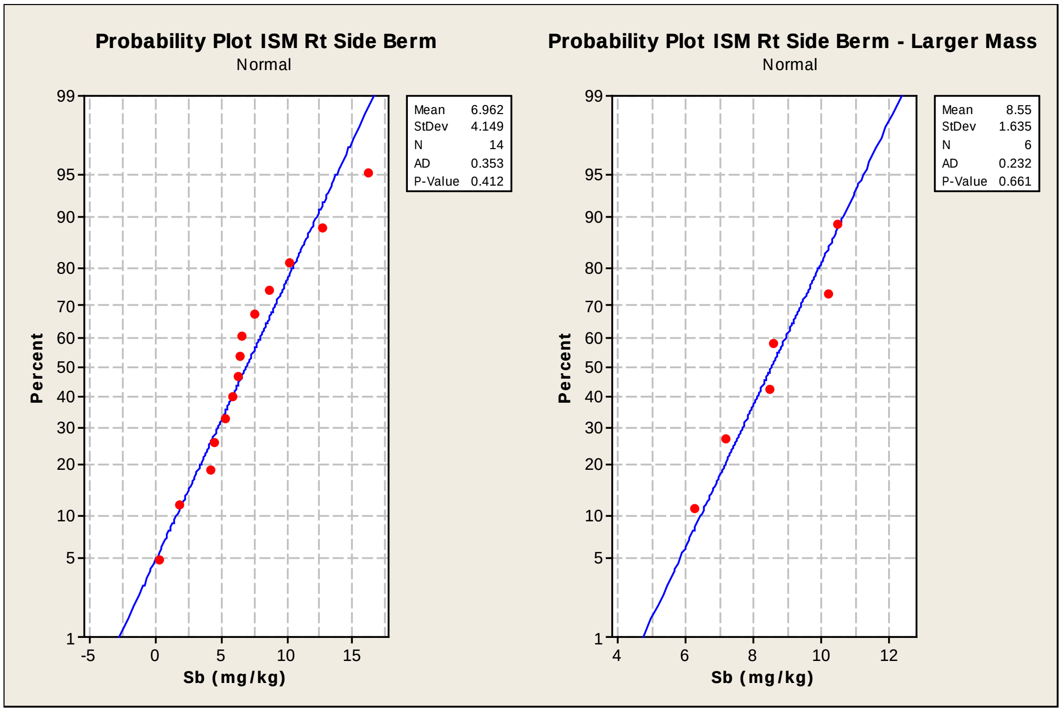
Descriptive Statistics: Sb (mg/kg)—ISM Rt Side Berm

Variable	N	Mean	SE Mean	StDev	Minimum	Q1	Median	Q3	Maximum
Sb (mg/kg)	14	6.96	1.11	4.15	0.30	4.42	6.41	9.14	16.30

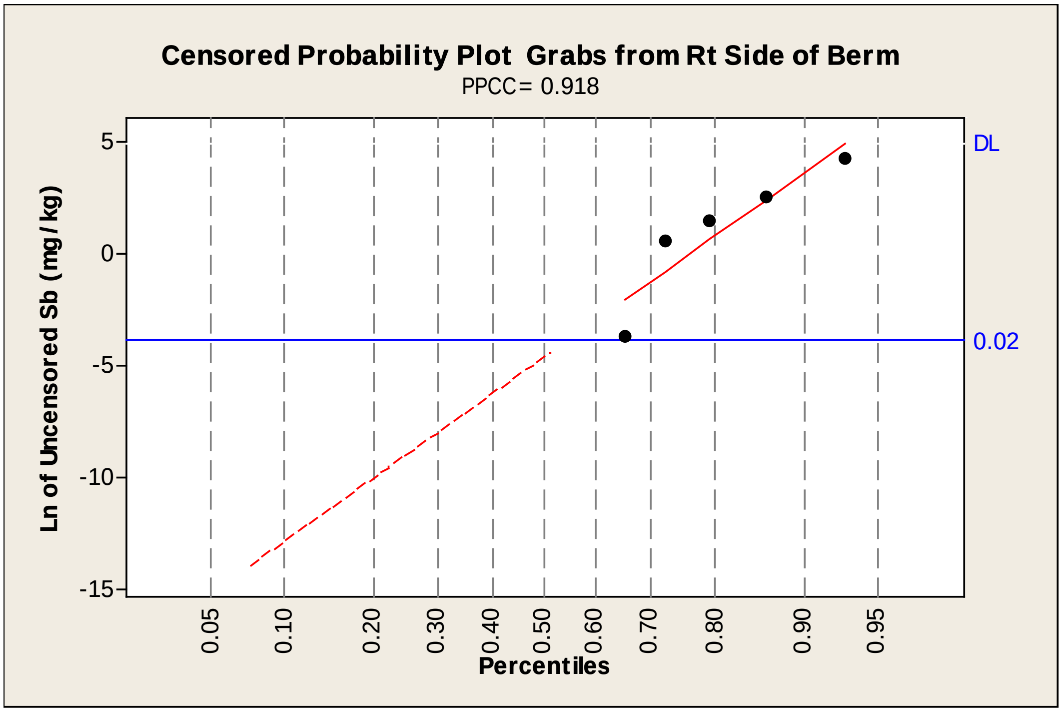
Descriptive Statistics: Sb (mg/kg)—ISM Rt Side Berm—Larger Mass

Variable	N	Mean	SE Mean	StDev	Minimum	Q1	Median	Q3	Maximum
Sb (mg/kg)	6	8.550	0.667	1.635	6.300	6.990	8.540	10.275	10.500





Probability Plot ISM Rt Side Berm
Normal
Mean 6.962
StDev 4.149
N 14
AD 0.353
P-Value 0.412
Percent
Sb (mg/kg)
Probability Plot ISM Rt Side Berm - Larger Mass
Normal
Mean 8.55
StDev 1.635
N 6
AD 0.232
P-Value 0.661
Percent
Sb (mg/kg)



Censored Probability Plot Grabs from Rt Side of Berm
PPCC= 0.918
Ln of Uncensored Sb (mg/kg)
DL
0.02
Percentiles

Mann-Whitney Test and CI: Rt Grab, ISM Rt Side Berm *
N Median
Rt Grab 12 -1.00, ISM Rt Side Berm 12 6.41
estimate for ETA1-ETA2 is -6.41
95.4 Percent CI for ETA1-ETA2 is (-7.66,-1.86), W = 104.0
Test of ETA1 = ETA2 verse ETA1 not = ETA2 is significant at 0.0086
The test is significant at 0.0078 (adjusted for ties). Use tie adjustment. All values below 0.02 were set = -1. If a median = -1, it means the median is <0.02

Mann-Whitney Test and CI: Rt Grab, ISM Rt Side Berm—Larger Mass *
N Median
Rt Grab 12 -1.00, ISM Rt Side Berm—Larger Mass 6 8.54
Point estimate for ETA1-ETA2 is -8.22
95.6 Percent CI for ETA1-ETA2 is (-10.48,-4.47), W = 90.0
Test of ETA1 = ETA2 verse ETA1 not = ETA2 is significant at 0.0277
The test is significant at 0.0234 (adjusted for ties). Use tie adjustment. All values below 0.02 were set = -1. If a median = -1, it means the median is <0.02
* The Minitab macro “CENSMW” was used to do a two-sided Mann-Kendal test, which computes rank sums for censored data.

Appendix H: Statistical Summary of Fort Wainwright Data

Introduction

The study area contains a set of 16 small-arms berms. As the berms are located near one another and were impacted by similar activities, the set of 16 berms was viewed as a single SU. Three grab samples were collected from each of the 16 berms; specifically, one grab was collected from the lower center, upper left, and upper right of each berm, resulting in a total of 48 grab samples for the entire SU (containing the 16 berms). The data set (n = 48) is denoted as "Grab." A set of 15 incremental samples (IS) consisting of 96 increments each (each with a mass of about 2 kg) was also collected from the berm SU. This data set is denoted (e.g., in boxplots and normal probability plots) as "IS" or "Berm IS." A set of 15 incremental samples were collected for the berm SU, but only 14 results were available for all the metals when the statistical evaluations were done.

Berm 11 was divided in half—a right half (R) and left half (L). A set of n = 12 incremental samples of 30 increments each was collected from each half of Berm 11. These data sets are denoted as "Berm 11 R IS" and "Berm 11 L IS."

All of the incremental samples were ground in a puck mill (5 by 60-s grinds). Each IS subsample mass was about 2 g and was prepared in the laboratory from 20 aliquots (randomly sampled after the sample was dried, sieved, and ground). The subsample mass of each of the grab samples was 1 g. The metals of interest are predominately Pb, Zn, and Cu. Sb was not evaluated as most of the Sb results were non-detections.

Appendix H-1 presents descriptive statistics for select metals. Appendix H-2 presents boxplots for the small-arms metals Pb, Cu, and Zn. Appendix H-3 presents normal probability plots. Appendix H-4 presents Kruskal-Wallis (KW) tests for the medians. Appendix H-5 presents statistical tests for the variances (Levene's test and F test). All statistical tests were done at the 95% level of confidence. Appendix H-6 presents boxplots and descrip-

tive statistics for grab background samples (n = 4) and incremental samples (n = 14) collected at a firing point (FP) SU. A set of 15 incremental samples were collected from the FP SU, but only 14 results were available when the statistical evaluations were done.

Appendix H-6 presents boxplots, individual value plots, and descriptive statistics for the following data sets:

- "Berm 11 IS"—Consists of the pooled data sets "Berm 11 R IS" and "Berm 11 L IS."
- "Berm IS"—Incremental sample data set for the 16 berms also denoted as "IS."
- "BKG Grab"—Set of 4 background grab samples.
- "FP IS"—Set of 14 incremental sample results collected at the FP. Each incremental sample was prepared from 96 increments.

Appendix H-7 summarizes all of the results (the grab and incremental samples) for Pb, Cu, and Zn. Appendix H-8 presents information (e.g., statistical plots) for evaluating the Cu FP and background results. Appendix H-9 summarizes the results for tests for the variances using the squared rank test.

Discussion and conclusions

1. Incremental sampling tends to normalize data. As shown by the boxplots in Appendix H-2, the "Grab" data sets for Pb, Cu, and Zn are very positively skewed and contain many large outliers. Similarly, the normal probability plots in Appendix H-3 indicate that the Pb, Cu, and Zn "Grab" data sets are not normal. In contrast, almost half the incremental sample data sets ("Berm 11 R IS," "Berm 11 L IS," and "IS") are normal (at the 95% level of confidence). For example, the "IS" Pb data set for the berm SU is normal but the Pb "Grab" data sets grossly deviates from a normal distribution. Although the incremental data sets are not consistently normal, the boxplots (Appendix H-2) and probability plots (Appendix H-3) suggest that the deviations from normality are less severe than for the corresponding "Grab" data sets. For example, the Cu "IS" data set is not normal but is only slightly positively skewed relative to the Cu "Grab" data set. A (natural) logarithm transform normalizes the Cu "IS" data set but not the Cu "Grab" data set, which still grossly deviates from normality.

2. Based on qualitative evaluations of the boxplots in Appendix H-2 and H-5, the variability of the "Grab" data sets seems to be much larger than the variability of the incremental sample data sets. The interquartile ranges (IQRs) are similar overall; but the "Grab" data sets are characterized by many large outliers, resulting in large concentration ranges (e.g., sample minima and maxima summarized in Appendix H-1). In contrast, the incremental sample data sets exhibit very few outliers; the few outliers that are shown in the boxplots are smaller than the grab outliers.

   As shown in Appendix H-5, the 95% Bonferroni confidence intervals of standard deviations of the "Grab" Pb, Cu, and Zn data sets span larger concentrations than the incremental sample data sets with no overlap, suggesting that the "Grab" standard deviations are larger than the incremental data set standard deviations.

   As shown in Appendix H-5, the non-parametric Levene's test (i.e., the Brown-Forsythe version that calculates absolute deviations from group medians) did not detect significant differences between the variances of any of the (untransformed) grab and incremental sample data sets for the berm SU. The Levene's test is more robust than the F-test for detected differences between variances, but the test can fail to detect differences when there are large deviations from normality and unequal sample sizes. The "Grab" data greatly deviates from a normal distribution and is twice as large as the "Berm IS" data set.

   As shown in Appendix H-5, when the Pb incremental sample data are log transformed, both the F test and Levene's test indicate the "Grab" Pb variance is significantly larger than the incremental sample variances. (The F-test was used because the logarithm-transformed Pb data sets are approximately normal, as shown in Appendix H-3).

   The squared rank test for the variance was also done to compare the variances of the "Grab" and "IS" Pb, Cu, and Zn data sets. The results are summarized in Appendix H-9. The squared rank test, a non-parametric test for equal variances, identified significant differences (well over the 95% level of confidence) for Pb and Cu. A significant difference for the Zn "Grab" and "IS" variances was detected at about the 85% confidence level.

3. On the basis of a qualitative evaluation of the sample means (e.g., Appendix H-1 and H-2), the “Grab” and “IS” sample means for Pb, Cu, and Zn are very similar. However, as indicated by the KW tests for the “IS” and “Grab” data sets in Appendix H-4.2, the medians of the “IS” data sets are consistently larger than the corresponding “Grab” medians. This is also consistent with the results in Appendix H-6. As shown in Appendix H-6, a two-sample T-Test (that assumes unequal variances) indicates the mean of the (natural) logarithm-transformed “IS” Pb data set is significantly larger than the mean of the logarithm transformed “Grab” Pb data set.

4. It has been observed that when UCL of means are calculated for environmental applications (e.g., exposure point concentrations for risk assessments), positively skewed data from grab samples tends to result in larger UCLs than normally distributed data from incremental sampling designs. ProUCL (Version 4.1.00) was used to calculate 95% UCLs for the Pb, Cu, and Zn “IS” and “Grab” data sets. The results are summarized in Appendix H-10. Even though the mean “IS” Pb concentration (460 mg/kg) is very similar to the mean “Grab” Pb concentration (430 mg/kg) and both sets of samples were collected represent the same study area (SU), the 95% UCL calculated from the positively skewed “Grab” Pb data (500 mg/kg) is twice as large as the 95% UCL calculated from the normal “IS” Pb data (1000 mg/kg). If only the first 10 results from the “Grab” Pb data set were available, the ProUCL would output a 95% adjusted gamma UCL of about 1900 mg/kg, which is nearly four times larger than the “IS” 95% UCL.

   The large variability (e.g., large outliers) and positive skew of the “Grab” data sets suggests that a relatively large sample size (e.g., $n > 30$) will likely be needed to characterize the distribution of metal concentrations to obtain a reasonable estimate of the population mean.

5. The incremental sampling method produced relatively consistent results. As shown in Appendix H-5, the variances of the Pb, Cu, and Zn “Berm 11 R IS,” “Berm 11 L,” and “IS” data sets do not significantly differ from one another. Similarly, the squared rank test for the variances (Appendix H-11) did not detect differences in the variances for “Berm 11 R IS” and “Berm 11 L IS” for Pb, Cu, or Zn. As shown in Appendix H-4.4, no significant differences were detected between the Cu and Zn incremental sample medians using the Kruskal-Wallis (KW) test.

The KW test did detect significant differences between the Pb medians for the three incremental sample data sets. The “Berm 11 R IS” and “Berm 11 L IS” data set Pb medians differed from one another by about 10% but differed from the “IS” median (for all 16 berms) by about 30%–40%. The differences between the Berm 11 and “IS” medians are large relative to the difference between the Pb medians for the two halves of Berm 11 (e.g., which equal the typical tolerance for instrumental analytical error). This suggests that, with respect to average Pb concentrations, there is more berm-to-berm heterogeneity than within-berm heterogeneity. The former likely accounts for much of the variability of the “IS” Pb results. As Berm 11 is located at the center of the range, it was likely that Berm 11 was impacted by more small-arms firing than a berm located closer to the range boundary.

6. On the basis of a qualitative evaluation of the boxplots, individual value plots, and descriptive statistics in Appendix H-7, it appears that there is no significant Pb contamination at the firing point SU. The firing point Pb concentrations are similar to background. The box and individual value plots also suggest that the berm and FP SUs exhibit Zn concentrations that are consistent with background concentrations. The plots also suggest that the concentrations of Cu for the berm and firing point SUs are elevated relative to background. It is suspected that the elevated Cu concentrations of the firing point SU are owing to releases of abraded particles from fired copper-jacketed bullets.

   As shown in Appendix H-9, the Cu “FP” and Cu “BKG Grab” data sets are approximately normal (within unequal variances). Even though the sample size of the background data set is small (n = 4), a two-sample T-Test was done to compare the mean background and firing point Cu concentrations. The mean Cu concentration of the firing point SU is significantly greater than the mean background concentration (at well over the 95% level of confidence).

7. Some assessment of bias was conducted using ProUCL, and Appendix H-12 shows these results. One of the observations of this analysis is that when upper confidence limits (UCL) of means are calculated for environmental applications (e.g., exposure point concentrations for risk assessments), positively skewed data from grab samples tends to result in larger UCLs than normally distributed data from incremental sampling designs.

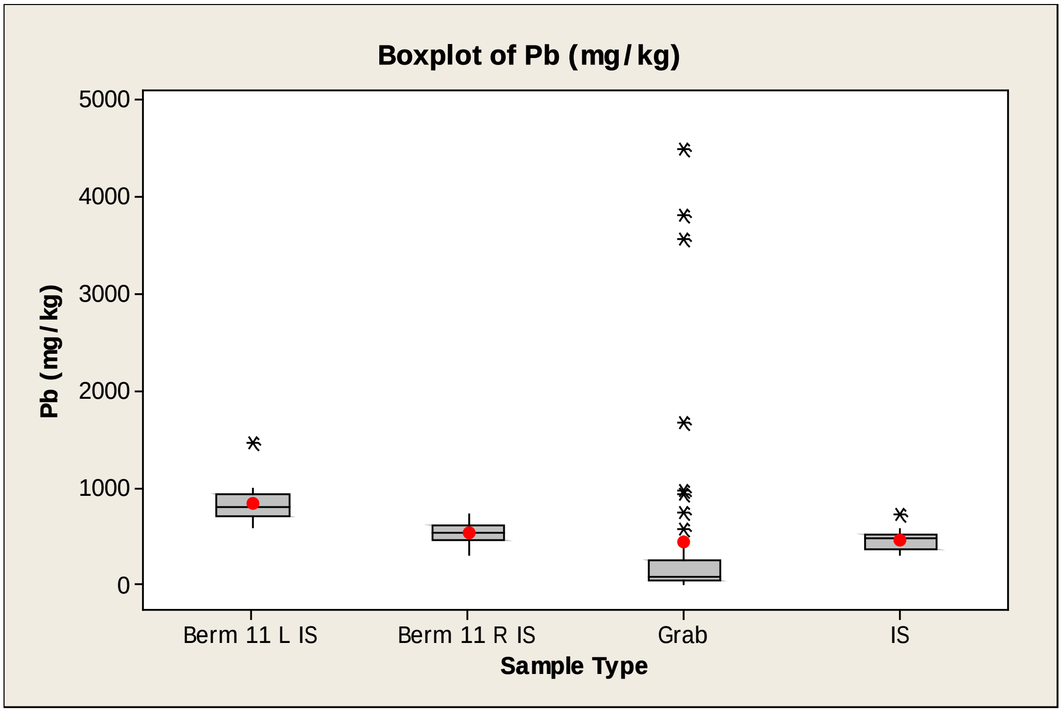
ProUCL (Version 4.1.00) was used to calculate 95% UCLs for the Pb, Cu, and Zn “ISM” and “Grab” data sets. Even though the mean “ISM” Pb concentration (460 mg/kg) is very similar to the mean “Grab” Pb concentration (430 mg/kg) and both sets of samples collected represent the same study area (DU), the 95% UCL calculated from the positively skewed “Grab” Pb data (1000 mg/kg) is twice as large as the 95% UCL calculated from the normal “ISM” Pb data (500 mg/kg). If only the first 10 results from the “Grab” Pb data set were available, the ProUCL would output a 95% adjusted gamma UCL of about 1900 mg/kg, which is nearly four times larger than the “ISM” 95% UCL. Although this type of analysis was not performed for the Kimama TS or Fort Eustis, similar outcomes and observations are expected.

Appendix H-1: Descriptive statistics (select metals)

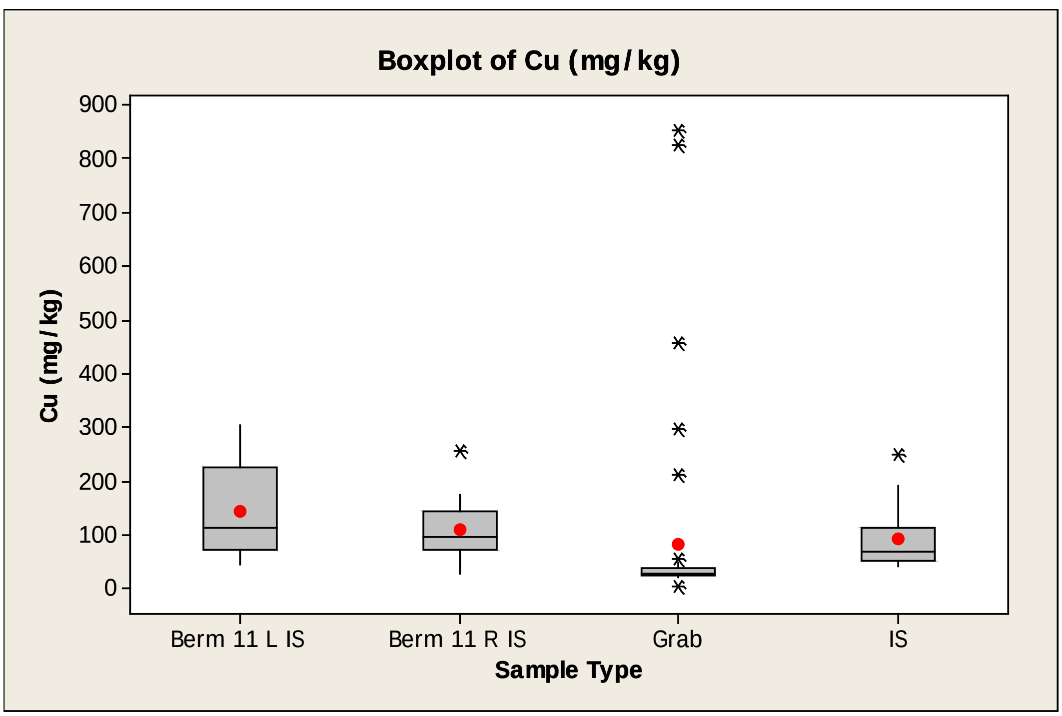
Variable	Sample Type	Total Count	N	Mean	StDev	Minimum	Median	Maximum
Al (mg/kg)	Berm 11 L IS	12	12	12750	419	12000	12800	13400
	Berm 11 R IS	12	12	12043	1888	6220	12650	13200
	Grab	48	48	9980	1655	1060	10100	14200
	IS	15	14	12936	440	12000	12950	13700
As (mg/kg)	Berm 11 L IS	12	12	7.1917	0.2810	6.8000	7.1400	7.8100
	Berm 11 R IS	12	12	6.773	1.030	3.560	7.010	7.320
	Grab	48	47	8.855	1.362	6.230	8.580	12.700
	IS	15	14	7.1057	0.2768	6.5800	7.1700	7.5400
Ba (mg/kg)	Berm 11 L IS	12	12	147.42	5.09	136.00	148.00	156.00
	Berm 11 R IS	12	12	142.78	22.44	74.40	148.00	163.00
	Grab	48	48	103.95	19.53	10.60	104.00	170.00
	IS	15	14	146.64	5.62	136.00	148.00	157.00
Ca (mg/kg)	Berm 11 L IS	12	12	6734.2	202.2	6380.0	6725.0	7070.0
	Berm 11 R IS	12	12	6534	1001	3460	6805	7150
	Grab	48	48	5566	1309	529	5535	9010
	IS	15	14	7022.1	192.9	6570.0	7065.0	7270.0
Co (mg/kg)	Berm 11 L IS	12	12	10.575	0.214	10.200	10.550	10.900
	Berm 11 R IS	12	12	9.906	1.457	5.330	10.300	10.600
	Grab	48	47	9.547	0.766	7.240	9.470	11.400
	IS	15	14	10.721	0.219	10.300	10.750	11.000
Cr (mg/kg)	Berm 11 L IS	12	12	306.42	31.86	260.00	295.50	383.00
	Berm 11 R IS	12	12	291.6	54.6	152.0	301.5	361.0
	Grab	48	48	18.853	2.783	2.040	19.200	22.600
	IS	15	14	285.79	22.92	246.00	289.50	319.00
Cu (mg/kg)	**Berm 11 L IS**	**12**	**12**	**144.3**	**87.3**	**44.7**	**112.5**	**304.0**
	Berm 11 R IS	**12**	**12**	**108.5**	**61.5**	**26.1**	**94.8**	**254.0**
	Grab	**48**	**48**	**81.0**	**176.9**	**2.6**	**27.4**	**852.0**
	IS	**15**	**14**	**91.1**	**60.9**	**39.5**	**69.3**	**247.0**
Fe (mg/kg)	Berm 11 L IS	12	12	21225	411	20600	21150	21800
	Berm 11 R IS	12	12	20033	2907	10900	20800	21400
	Grab	48	48	18143	2820	1960	18400	22700
	IS	15	14	21493	439	20600	21650	22000
K (mg/kg)	Berm 11 L IS	12	12	1803.3	87.7	1690.0	1800.0	1960.0
	Berm 11 R IS	12	12	1704.4	273.7	883.0	1780.0	1910.0
	Grab	48	48	1004.6	174.7	112.0	1015.0	1340.0
	IS	15	14	1802.1	96.7	1590.0	1810.0	1970.0
Mg (mg/kg)	Berm 11 L IS	12	12	5663.3	112.5	5520.0	5665.0	5870.0
	Berm 11 R IS	12	12	5340	771	2910	5585	5660
	Grab	48	48	5235	817	558	5260	6540
	IS	15	14	5789.3	120.5	5530.0	5815.0	5960.0

Variable	Sample Type	Total Count	N	Mean	StDev	Minimum	Median	Maximum
Mn (mg/kg)	Berm 11 L IS	12	12	334.83	7.21	326.00	334.00	351.00
	Berm 11 R IS	12	12	319.5	46.6	174.0	333.5	343.0
	Grab	48	48	290.51	48.85	29.50	292.50	384.00
	IS	15	14	341.29	7.05	326.00	343.00	350.00
Na (mg/kg)	Berm 11 L IS	12	12	756.92	31.36	695.00	759.50	811.00
	Berm 11 R IS	12	12	740.8	113.8	397.0	772.5	819.0
	Grab	48	48	475.4	117.5	44.7	481.0	744.0
	IS	15	14	780.86	28.32	722.00	783.00	829.00
Ni (mg/kg)	Berm 11 L IS	12	12	25.358	0.610	24.400	25.500	26.500
	Berm 11 R IS	12	12	24.01	3.54	13.00	24.80	26.50
	Grab	48	48	21.124	3.139	2.260	21.650	25.300
	IS	15	14	25.557	0.624	24.200	25.700	26.600
Pb (mg/kg)	**Berm 11 L IS**	**12**	**12**	**845.9**	**226.5**	**590.0**	**792.5**	**1460.0**
	Berm 11 R IS	**12**	**12**	**529.2**	**108.7**	**302.0**	**534.5**	**722.0**
	Grab	**48**	**48**	**432**	**978**	**5**	**86**	**4500**
	IS	**15**	**14**	**457.8**	**112.3**	**311.0**	**474.0**	**732.0**
V (mg/kg)	Berm 11 L IS	12	12	41.425	1.078	39.600	41.400	43.100
	Berm 11 R IS	12	12	39.30	5.94	20.90	40.90	43.10
	Grab	48	48	34.837	5.316	3.590	35.350	41.400
	IS	15	14	41.957	1.204	39.700	41.900	44.100
Zn (mg/kg)	**Berm 11 L IS**	**12**	**12**	**62.02**	**9.58**	**52.90**	**57.50**	**79.00**
	Berm 11 R IS	**12**	**12**	**55.84**	**10.91**	**27.20**	**56.85**	**72.10**
	Grab	**48**	**48**	**52.64**	**22.34**	**4.88**	**47.90**	**146.00**
	IS	**15**	**14**	**55.76**	**7.22**	**49.80**	**53.00**	**74.30**

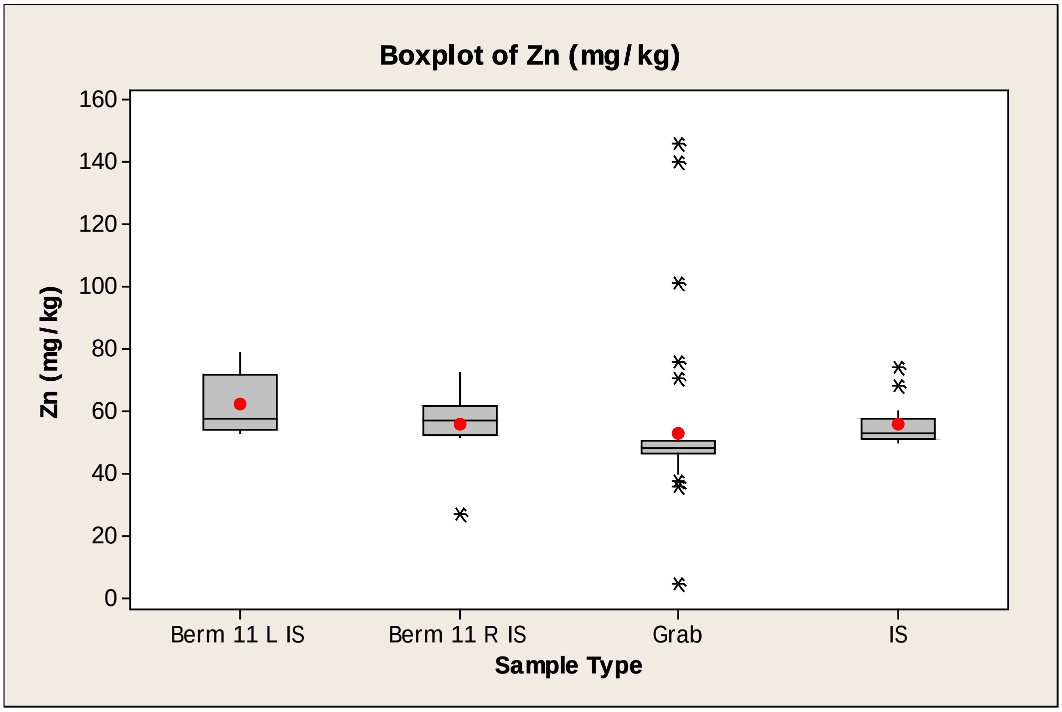
Appendix H-2: Boxplots (small-arms metals)



Red dot = Mean

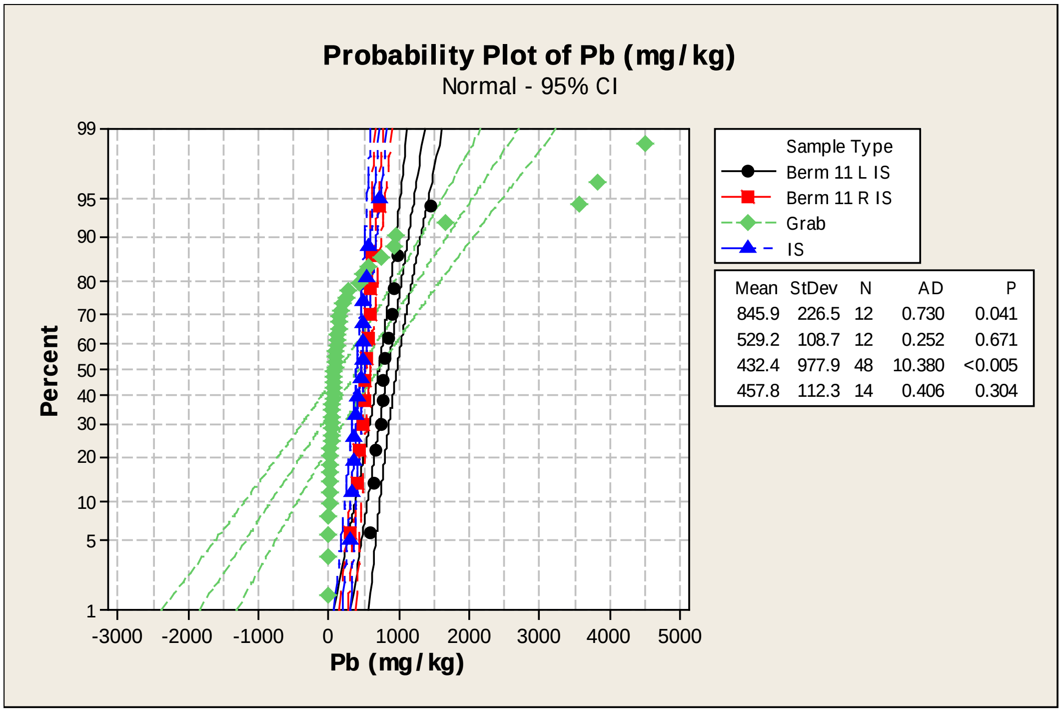


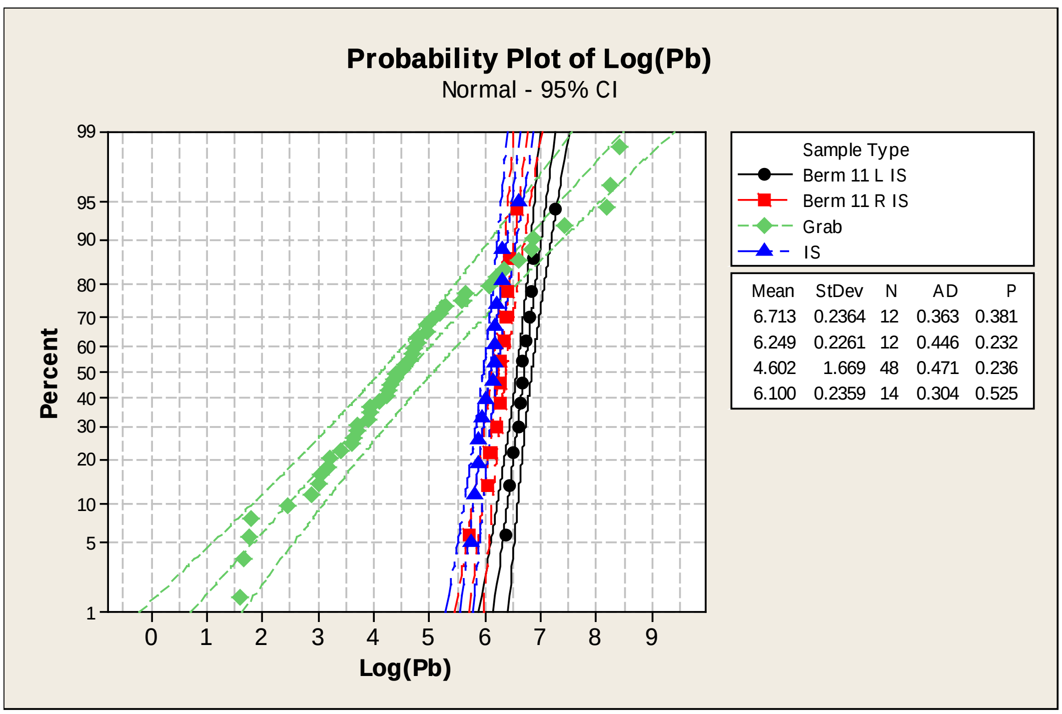
Red dot = Mean

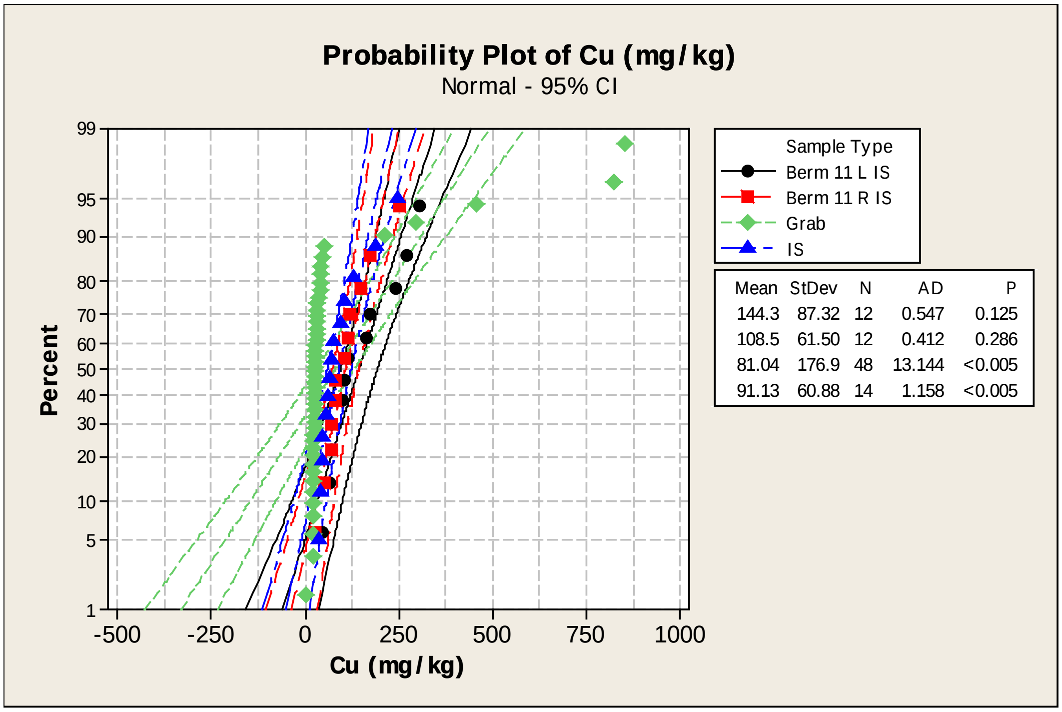

Boxplot of Zn (mg/kg)
Zn (mg/kg)
160
140
120
100
80
60
40
20
0
Berm 11 L IS
Berm 11 R IS
Grab
IS
Sample Type

Red dot = Mean

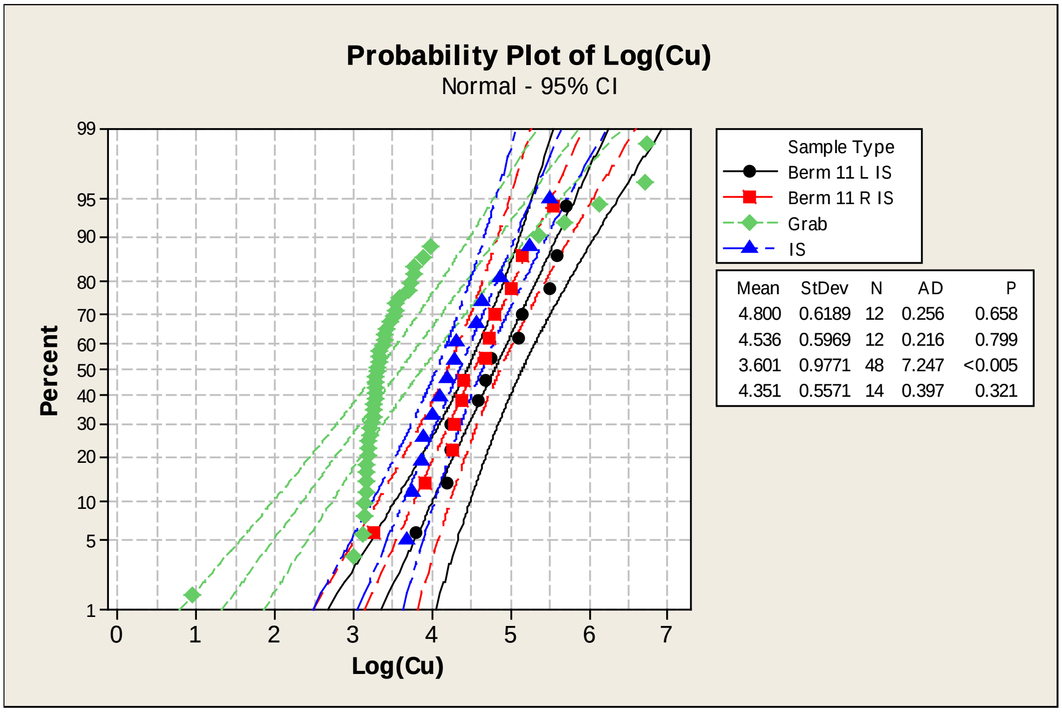
Appendix H-3: Normal probability plots (small-arms metals)



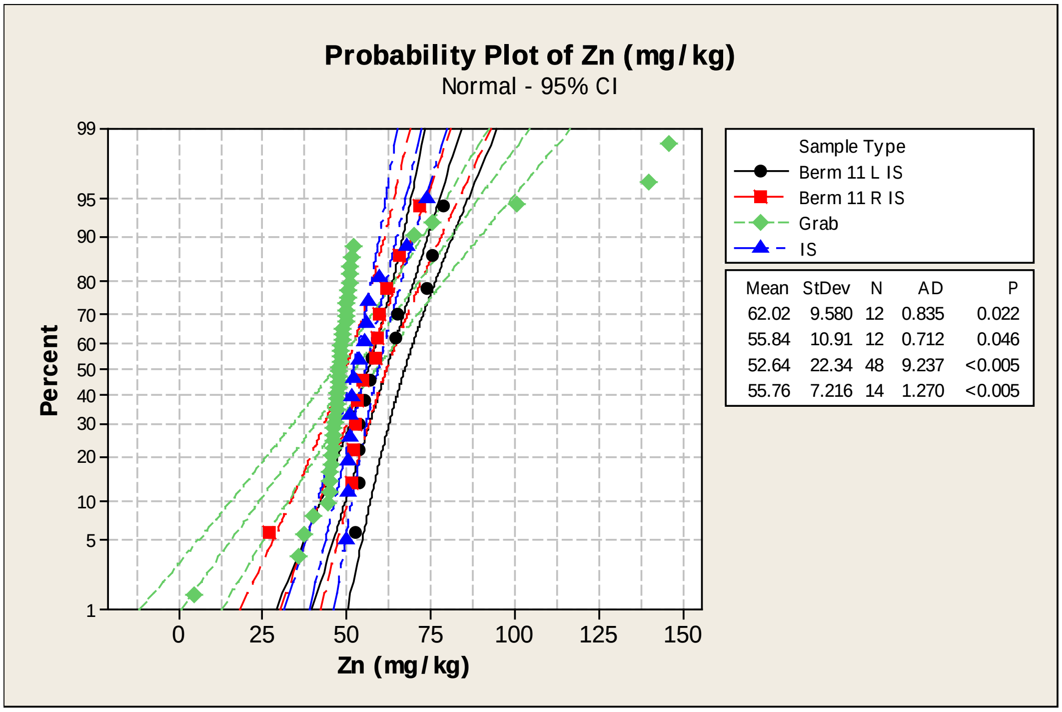


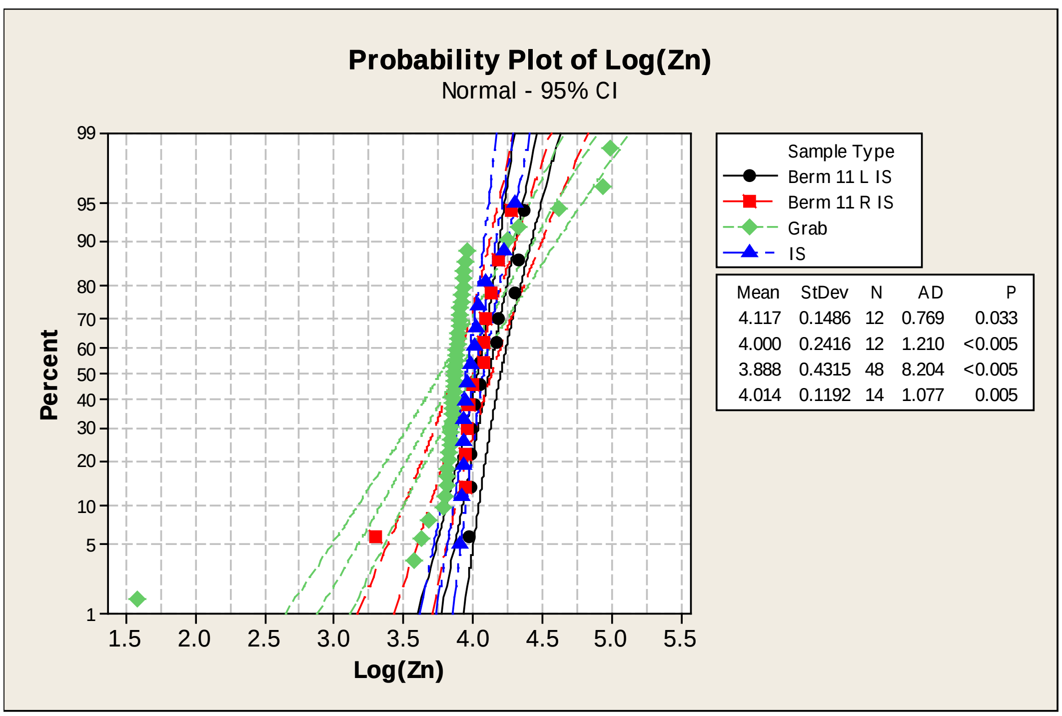


Probability Plot of Cu (mg/kg)
Normal - 95% CI
Sample Type
Berm 11 L IS
Berm 11 R IS
Grab
IS
Mean StDev N AD P
144.3 87.32 12 0.547 0.125
108.5 61.50 12 0.412 0.286
81.04 176.9 48 13.144 <0.005
91.13 60.88 14 1.158 <0.005
Percent
Cu (mg/kg)



Probability Plot of Log(Cu)
Normal - 95% CI
Sample Type
Berm 11 L IS
Berm 11 R IS
Grab
IS
Mean StDev N AD P
4.800 0.6189 12 0.256 0.658
4.536 0.5969 12 0.216 0.799
3.601 0.9771 48 7.247 <0.005
4.351 0.5571 14 0.397 0.321
Percent
Log(Cu)


Probability Plot of Zn (mg/kg)
Normal - 95% CI
Percent
Zn (mg/kg)
Sample Type
Berm 11 L IS
Berm 11 R IS
Grab
IS
Mean StDev N AD P
62.02 9.580 12 0.835 0.022
55.84 10.91 12 0.712 0.046
52.64 22.34 48 9.237 <0.005
55.76 7.216 14 1.270 <0.005


Probability Plot of Log(Zn)
Normal - 95% CI
Percent
Log(Zn)
Sample Type
Berm 11 L IS
Berm 11 R IS
Grab
IS
Mean StDev N AD P
4.117 0.1486 12 0.769 0.033
4.000 0.2416 12 1.210 <0.005
3.888 0.4315 48 8.204 <0.005
4.014 0.1192 14 1.077 0.005

Appendix H-4: Kruskal-Wallis tests (small-arms metals)

H-4.1. Comparison of the medians of the IS and Grab data sets

Kruskal-Wallis Test: Pb (mg/kg) versus Sample Type

```
86 cases were used. 1 cases contained missing values
Kruskal-Wallis Test on Pb (mg/kg)
Sample Type    N  Median  Ave Rank      Z
Berm 11 L IS  12  792.50      73.9   4.54
Berm 11 R IS  12  534.50      57.0   2.01
Grab          48   85.65      30.7  -5.36
IS            14  474.00      49.9   1.05
Overall       86              43.5
H = 34.85  DF = 3  P = 0.000
H = 34.85  DF = 3  P = 0.000  (adjusted for ties)
```

Kruskal-Wallis Test: Cu (mg/kg) versus Sample Type

```
86 cases were used. 1 cases contained missing values
Kruskal-Wallis Test on Cu (mg/kg)
Sample Type    N  Median  Ave Rank      Z
Berm 11 L IS  12  112.50      66.6   3.45
Berm 11 R IS  12   94.75      61.3   2.67
Grab          48   27.45      29.2  -5.97
IS            14   69.25      57.4   2.28
Overall       86              43.5
H = 36.46  DF = 3  P = 0.000
H = 36.46  DF = 3  P = 0.000  (adjusted for ties)
```

Kruskal-Wallis Test: Zn (mg/kg) versus Sample Type

```
86 cases were used, 1 cases contained missing values
Kruskal-Wallis Test on Zn (mg/kg)
Sample Type    N  Median  Ave Rank      Z
Berm 11 L IS  12   57.50      68.2   3.70
Berm 11 R IS  12   56.85      58.9   2.30
Grab          48   47.90      29.9  -5.68
IS            14   53.00      55.8   2.02
Overall       86              43.5
H = 33.98  DF = 3  P = 0.000
H = 33.99  DF = 3  P = 0.000  (adjusted for ties)
```

H-4.2. Comparison of "Grab" and "IS" data sets

```
Kruskal-Wallis Test: Pb (mg/kg) versus Sample Type
62 cases were used, 1 cases contained missing values
Kruskal-Wallis Test on Pb (mg/kg)
Sample Type   N  Median  Ave Rank      Z
Grab         48   85.65      27.2  -3.50
IS           14  474.00      46.4   3.50
Overall      62              31.5
H = 12.26  DF = 1  P = 0.000
```

```
Kruskal-Wallis Test: Cu (mg/kg) versus Sample Type
62 cases were used, 1 cases contained missing values
Kruskal-Wallis Test on Cu (mg/kg)
Sample Type   N  Median  Ave Rank      Z
Grab         48   27.45      26.2  -4.28
IS           14   69.25      49.6   4.28
Overall      62              31.5
H = 18.29  DF = 1  P = 0.000
H = 18.29  DF = 1  P = 0.000  (adjusted for ties)
```

```
Kruskal-Wallis Test: Zn (mg/kg) versus Sample Type
62 cases were used, 1 cases contained missing values
Kruskal-Wallis Test on Zn (mg/kg)
Sample Type   N  Median  Ave Rank      Z
Grab         48   47.90      26.6  -3.97
IS           14   53.00      48.4   3.97
Overall      62              31.5
H = 15.79  DF = 1  P = 0.000
H = 15.79  DF = 1  P = 0.000  (adjusted for ties)
```

H-4.3 .Comparison of IS medians of the right and left halves of Berm 11

```
Kruskal-Wallis Test: Pb (mg/kg) versus Sample Type
Kruskal-Wallis Test on Pb (mg/kg)
Sample Type    N  Median  Ave Rank      Z
Berm 11 L IS  12   792.5      18.1   3.87
Berm 11 R IS  12   534.5       6.9  -3.87
Overall       24              12.5
H = 14.96  DF = 1  P = 0.000
MTB > Kruskal-Wallis 'Cu (mg/kg)' 'Sample Type'.

Kruskal-Wallis Test: Cu (mg/kg) versus Sample Type
Kruskal-Wallis Test on Cu (mg/kg)
Sample Type    N  Median  Ave Rank      Z
Berm 11 L IS  12  112.50      13.4   0.64
Berm 11 R IS  12   94.75      11.6  -0.64
Overall       24              12.5
H = 0.40  DF = 1  P = 0.525
H = 0.40  DF = 1  P = 0.525  (adjusted for ties)

Kruskal-Wallis Test: Zn (mg/kg) versus Sample Type
Kruskal-Wallis Test on Zn (mg/kg)
Sample Type    N  Median  Ave Rank      Z
Berm 11 L IS  12   57.50      14.3   1.21
Berm 11 R IS  12   56.85      10.8  -1.21
Overall       24              12.5
H = 1.47  DF = 1  P = 0.225
H = 1.47  DF = 1  P = 0.225  (adjusted for ties)
```

H-4.4. Comparison of IS medians

Kruskal-Wallis Test: Pb (mg/kg) versus Sample Type

```
38 cases were used, 1 cases contained missing values
Kruskal-Wallis Test on Pb (mg/kg)
Sample Type    N  Median  Ave Rank      Z
Berm 11 L IS  12   792.5      31.8   4.65
Berm 11 R IS  12   534.5      17.0  -0.94
IS            14   474.0      11.1  -3.57
Overall       38              19.5
H = 23.44  DF = 2  P = 0.000
```

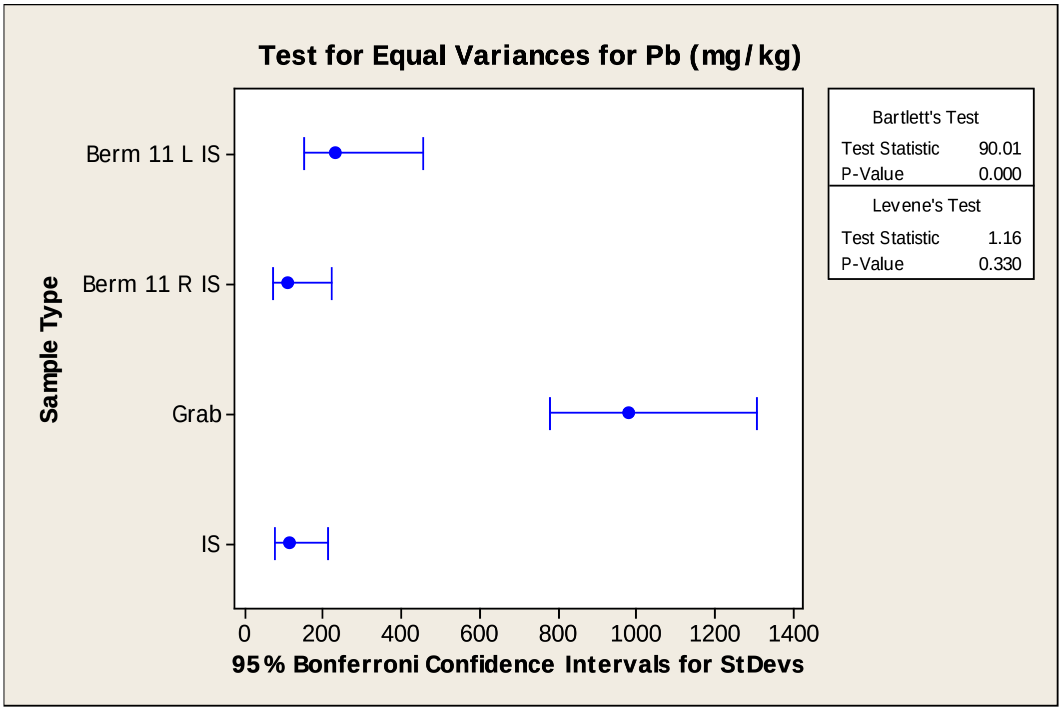
Kruskal-Wallis Test: Cu (mg/kg) versus Sample Type

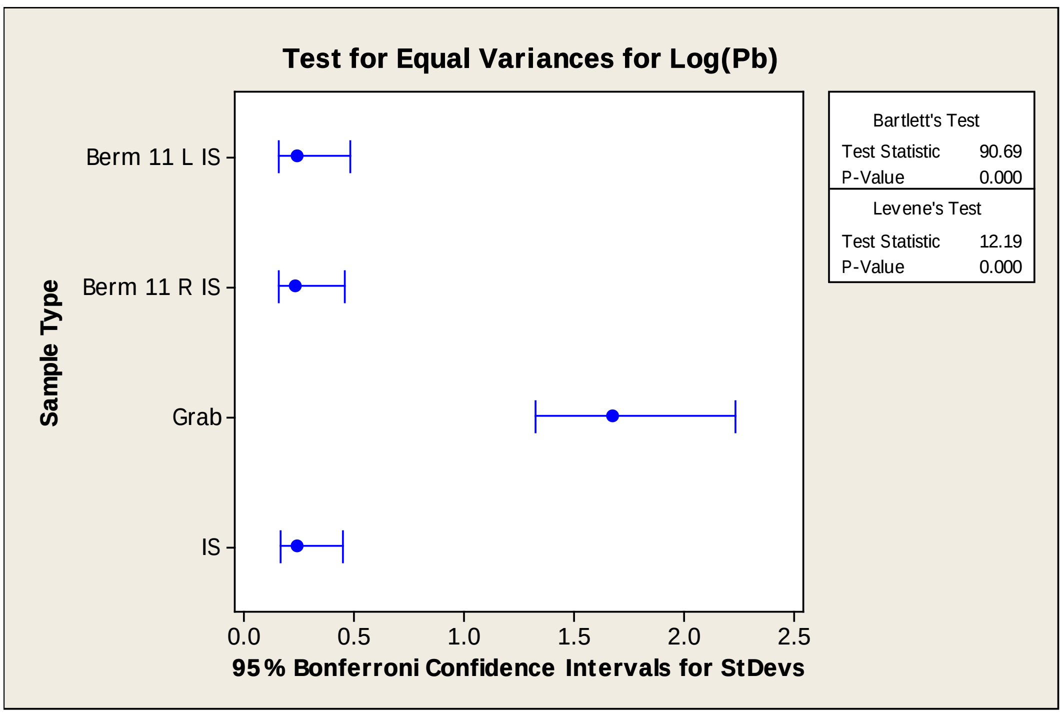
```
38 cases were used, 1 cases contained missing values
Kruskal-Wallis Test on Cu (mg/kg)
Sample Type    N  Median  Ave Rank      Z
Berm 11 L IS  12  112.50      23.4   1.48
Berm 11 R IS  12   94.75      20.5   0.38
IS            14   69.25      15.3  -1.79
Overall       38              19.5
H = 3.60  DF = 2  P = 0.165
H = 3.60  DF = 2  P = 0.165  (adjusted for ties)
```

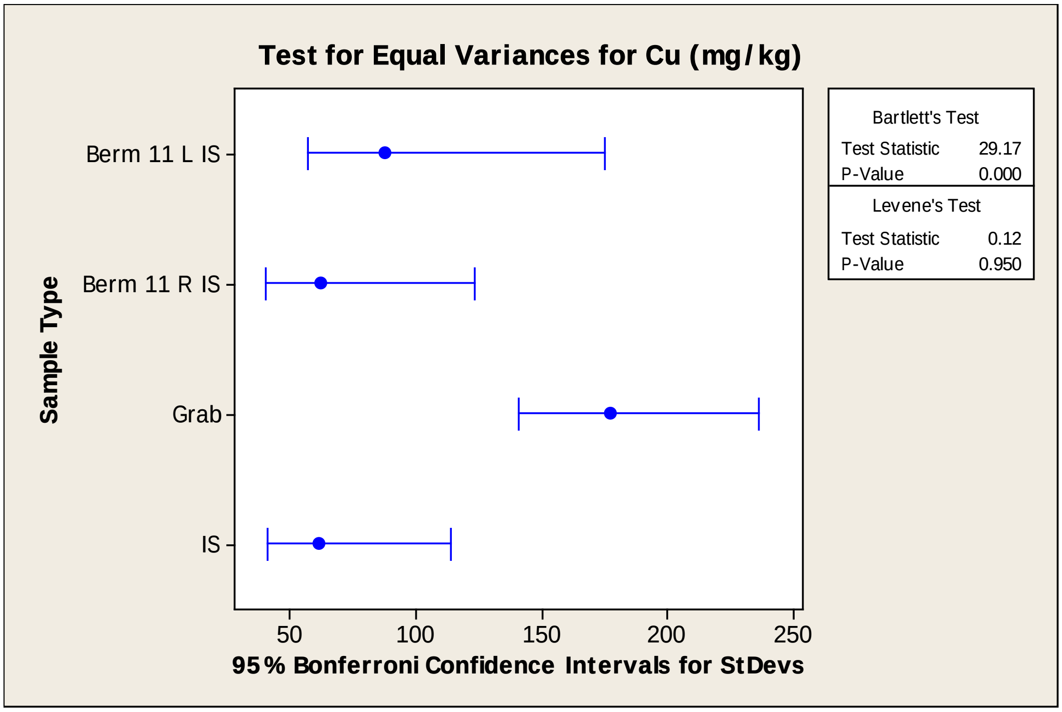
Kruskal-Wallis Test: Zn (mg/kg) versus Sample Type

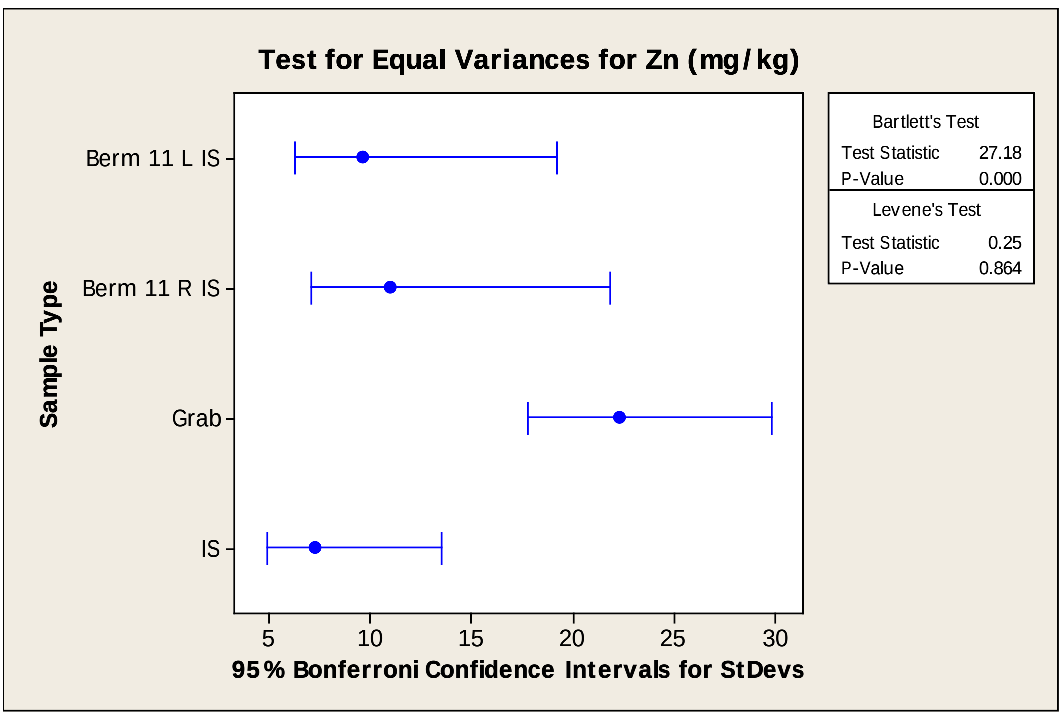
```
38 cases were used, 1 cases contained missing values
Kruskal-Wallis Test on Zn (mg/kg)
Sample Type    N  Median  Ave Rank      Z
Berm 11 L IS  12   57.50      24.8   1.99
Berm 11 R IS  12   56.85      19.5   0.00
IS            14   53.00      15.0  -1.92
Overall       38              19.5
H = 5.05  DF = 2  P = 0.080
H = 5.05  DF = 2  P = 0.080  (adjusted for ties)
```

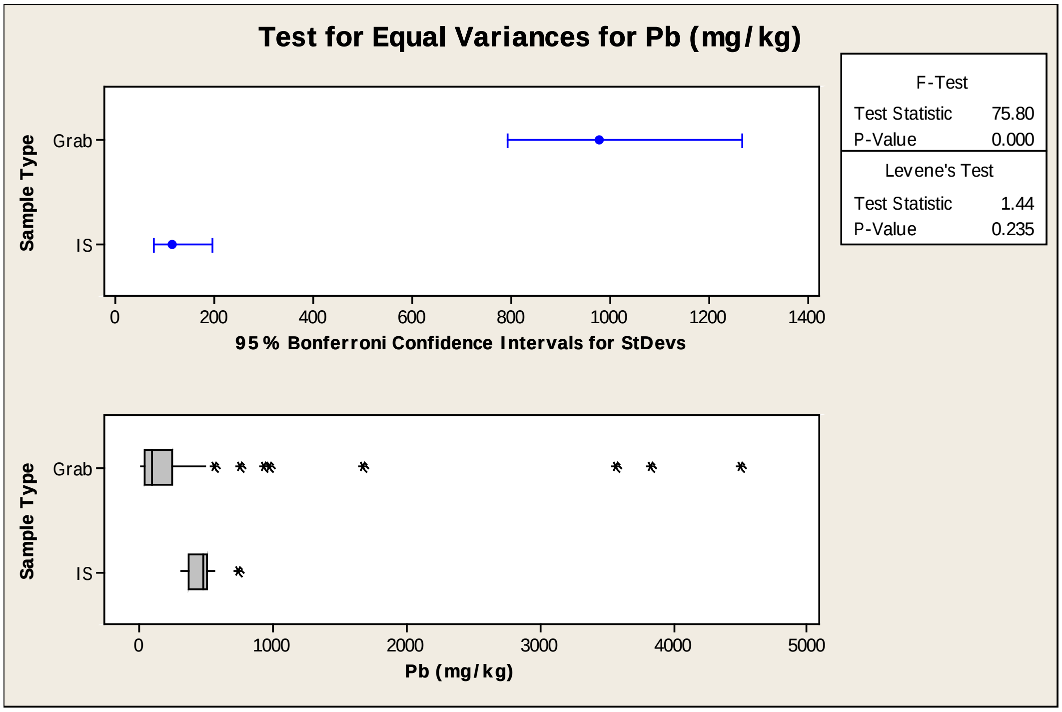
Appendix H-5: Tests for variances



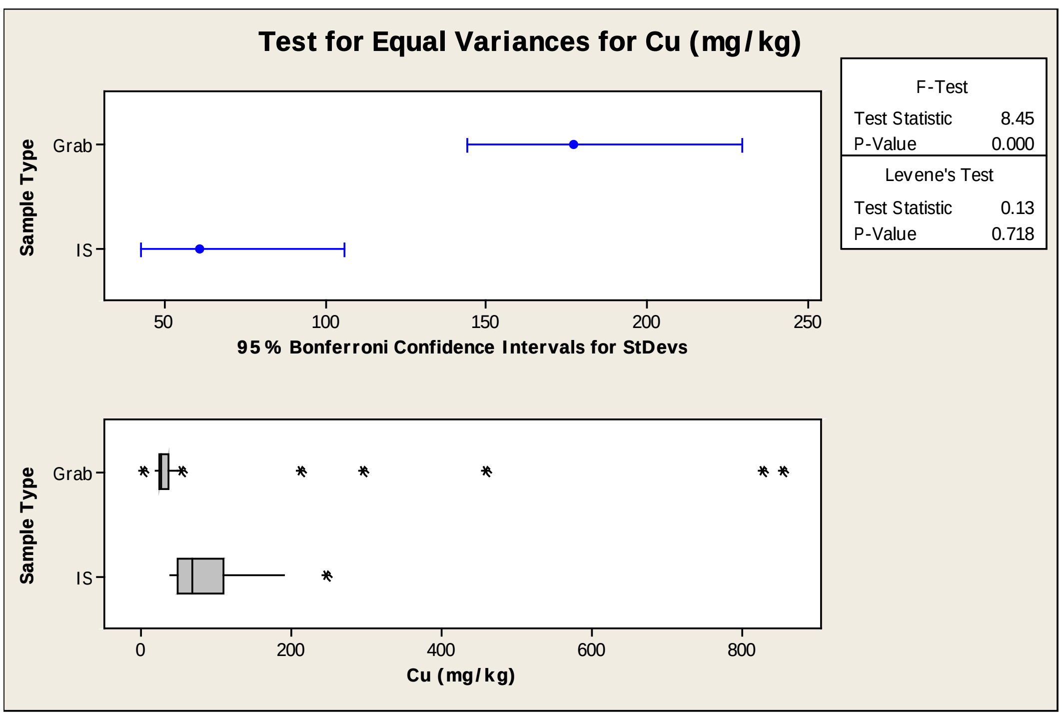



Test for Equal Variances for Cu (mg/kg)
Sample Type
Berm 11 L IS
Berm 11 R IS
Grab
IS
50
100
150
200
250
95% Bonferroni Confidence Intervals for StDevs
Bartlett's Test
Test Statistic 29.17
P-Value 0.000
Levene's Test
Test Statistic 0.12
P-Value 0.950

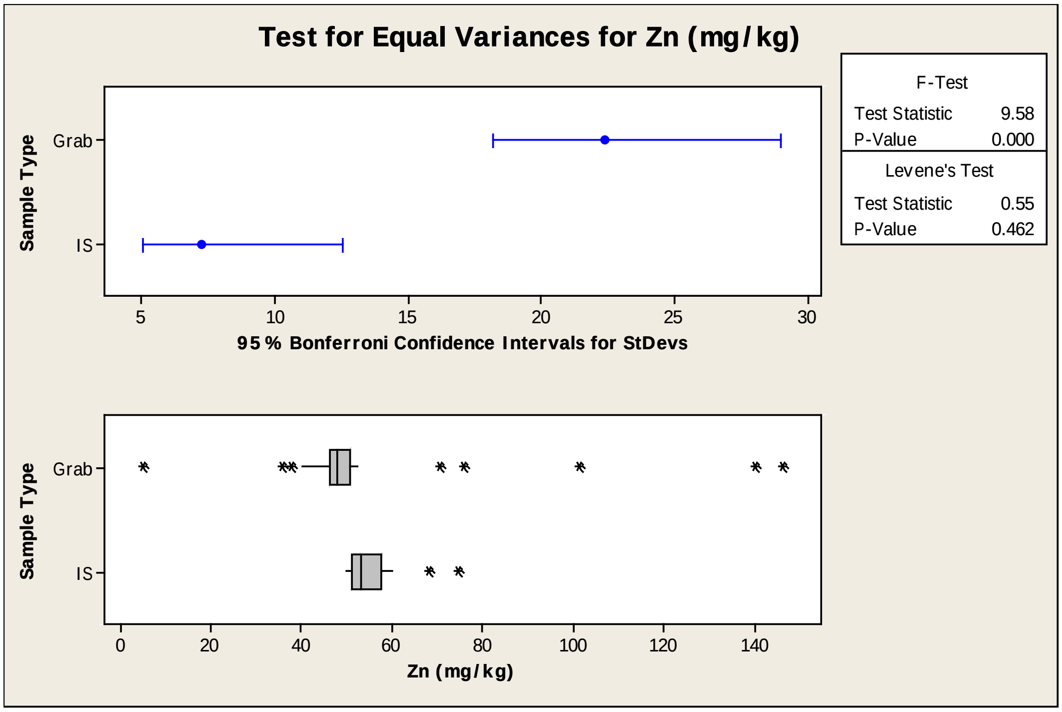

Test for Equal Variances for Zn (mg/kg)
Sample Type
Berm 11 L IS
Berm 11 R IS
Grab
IS
5
10
15
20
25
30
95% Bonferroni Confidence Intervals for StDevs
Bartlett's Test
Test Statistic 27.18
P-Value 0.000
Levene's Test
Test Statistic 0.25
P-Value 0.864

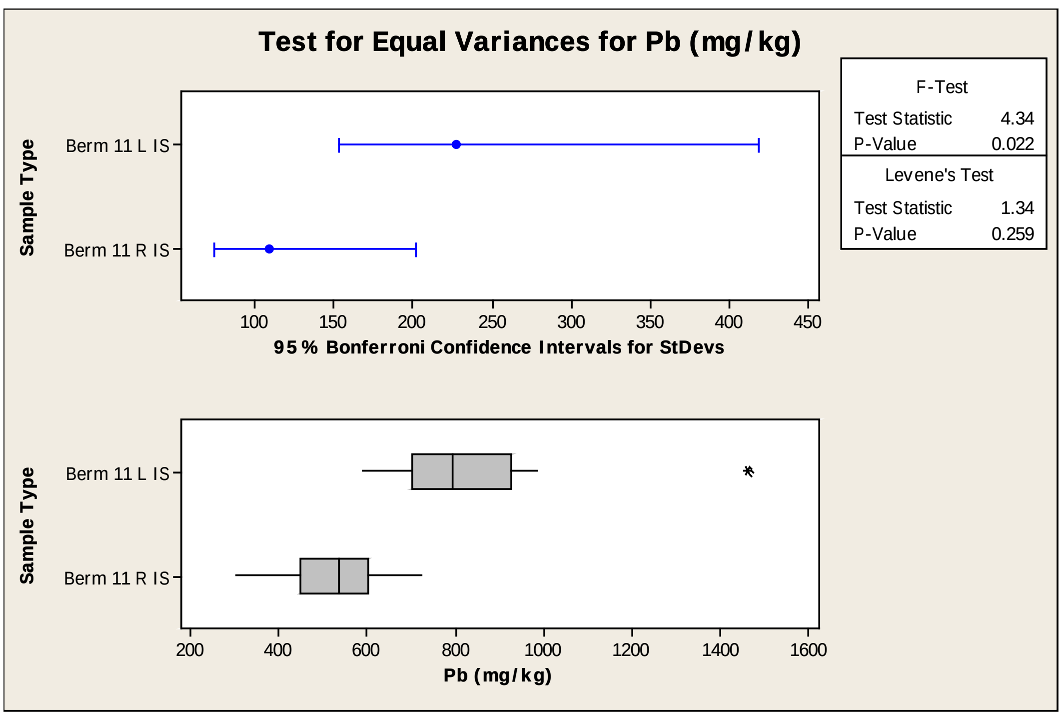


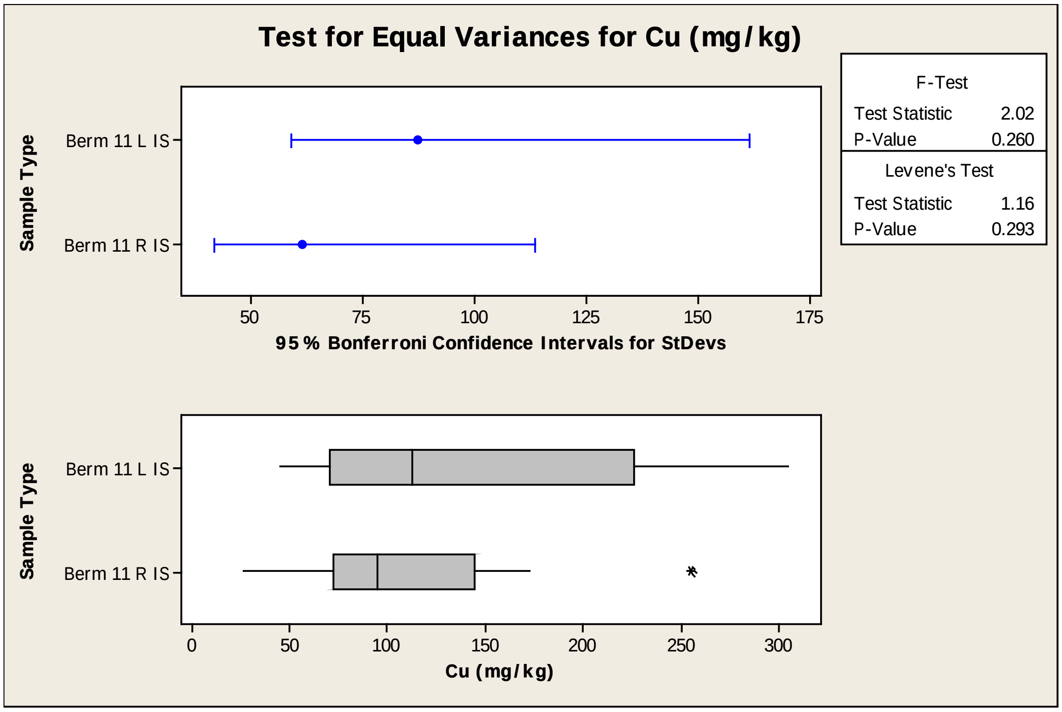
Test for Equal Variances for Pb (mg/kg)
F-Test
Test Statistic 75.80
P-Value 0.000
Levene's Test
Test Statistic 1.44
P-Value 0.235
Sample Type
Grab
IS
0
200
400
600
800
1000
1200
1400
95% Bonferroni Confidence Intervals for StDevs
0
1000
2000
3000
4000
5000
Pb (mg/kg)

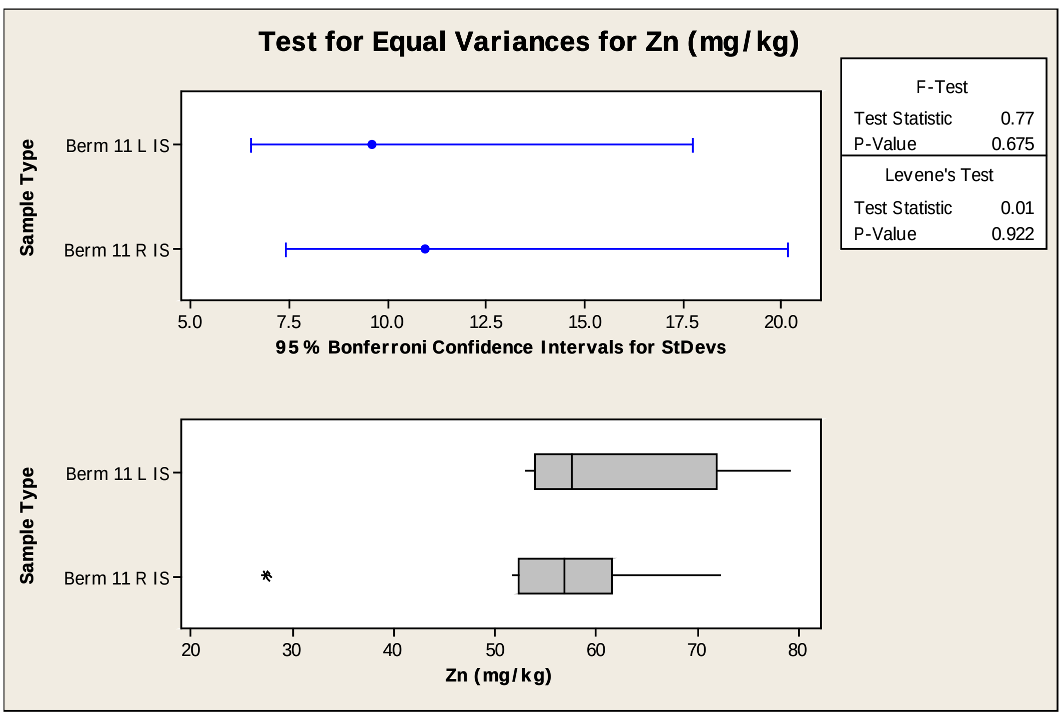


Test for Equal Variances for Cu (mg/kg)
F-Test
Test Statistic 8.45
P-Value 0.000
Levene's Test
Test Statistic 0.13
P-Value 0.718
Sample Type
Grab
IS
50
100
150
200
250
95% Bonferroni Confidence Intervals for StDevs
0
200
400
600
800
Cu (mg/kg)


Test for Equal Variances for Zn (mg/kg)
F-Test
Test Statistic 9.58
P-Value 0.000
Levene's Test
Test Statistic 0.55
P-Value 0.462
Sample Type
Grab
IS
5 10 15 20 25 30
95% Bonferroni Confidence Intervals for StDevs
0 20 40 60 80 100 120 140
Zn (mg/kg)


Test for Equal Variances for Pb (mg/kg)
F-Test
Test Statistic 4.34
P-Value 0.022
Levene's Test
Test Statistic 1.34
P-Value 0.259
Sample Type
Berm 11 L IS
Berm 11 R IS
100 150 200 250 300 350 400 450
95% Bonferroni Confidence Intervals for StDevs
200 400 600 800 1000 1200 1400 1600
Pb (mg/kg)


Test for Equal Variances for Cu (mg/kg)
F-Test
Test Statistic 2.02
P-Value 0.260
Levene's Test
Test Statistic 1.16
P-Value 0.293
Sample Type
Berm 11 L IS
Berm 11 R IS
50 75 100 125 150 175
95% Bonferroni Confidence Intervals for StDevs
0 50 100 150 200 250 300
Cu (mg/kg)


Test for Equal Variances for Zn (mg/kg)
F-Test
Test Statistic 0.77
P-Value 0.675
Levene's Test
Test Statistic 0.01
P-Value 0.922
Sample Type
Berm 11 L IS
Berm 11 R IS
5.0 7.5 10.0 12.5 15.0 17.5 20.0
95% Bonferroni Confidence Intervals for StDevs
20 30 40 50 60 70 80
Zn (mg/kg)

Appendix H-6: Two-sample t tests and ANOVA tests for log-transformed Pb results

One-way ANOVA: Log(Pb) versus Sample Type

```
Source       DF      SS     MS      F      P
Sample Type   3   66.72  22.24  13.73  0.000
Error        82  132.83   1.62
Total        85  199.56
S = 1.273   R-Sq = 33.43%   R-Sq(adj) = 31.00%

                                Individual 95% CIs For Mean Based on Pooled
StDev
Level          N   Mean  StDev  --------+---------+---------+---------+-
Berm 11 L IS  12  6.713  0.236                    (------*------)
Berm 11 R IS  12  6.249  0.226               (------*-------)
Grab          48  4.602  1.669  (---*---)
IS            14  6.100  0.236              (------*------)
                                --------+---------+---------+---------+-
                                      5.0       6.0       7.0       8.0
Pooled StDev = 1.273
```

Two-Sample T-Test and CI: Log(Pb), Sample Type

```
Two-sample T for Log(Pb)
Sample
Type     N   Mean  StDev  SE Mean
Grab    48   4.60   1.67     0.24
IS      14  6.100  0.236    0.063
Difference = mu (Grab) - mu (IS), Estimate for difference:  -1.498,
95% CI for difference:  (-1.998, -0.999)
T-Test of difference = 0 (verse not =): T-Value = -6.02  P-Value = 0.000  DF
= 52
```

Two-Sample T-Test and CI: Log(Pb), Sample Type

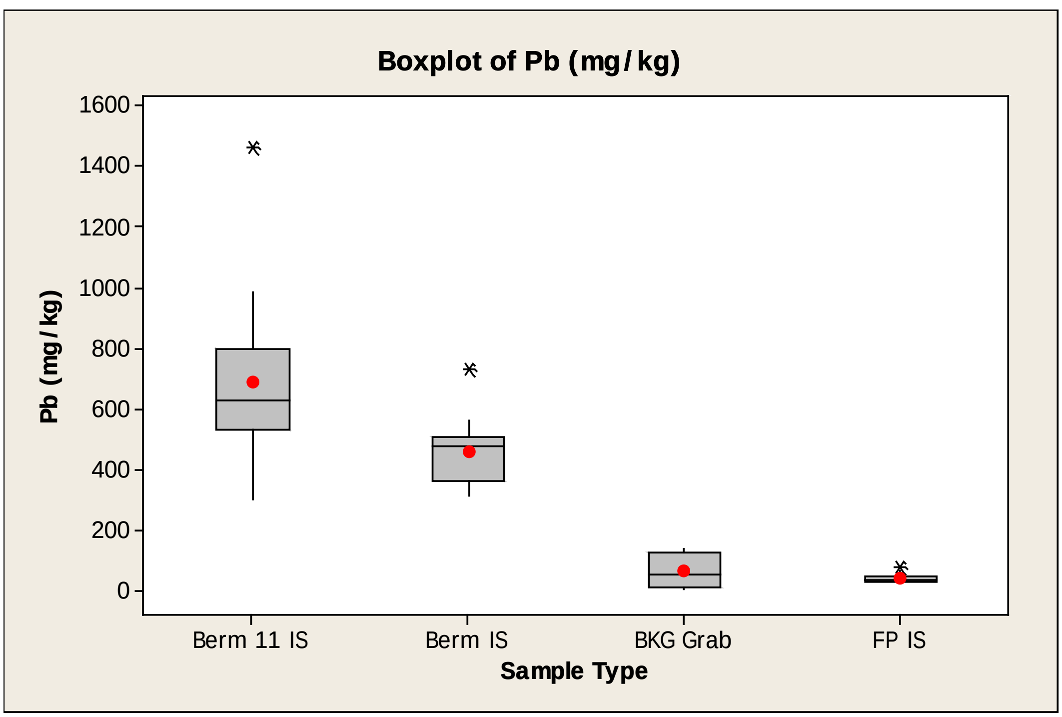
```
Two-sample T for Log(Pb)
Sample Type    N   Mean  StDev  SE Mean
Berm 11 L IS  12  6.713  0.236    0.068
Berm 11 R IS  12  6.249  0.226    0.065
Difference = mu (Berm 11 L IS) - mu (Berm 11 R IS), Estimate for difference:
0.4633
95% CI for difference:  (0.2675, 0.6592)
T-Test of difference = 0 (verse not =): T-Value = 4.91  P-Value = 0.000  DF =
22
Both use Pooled StDev = 0.2313
```

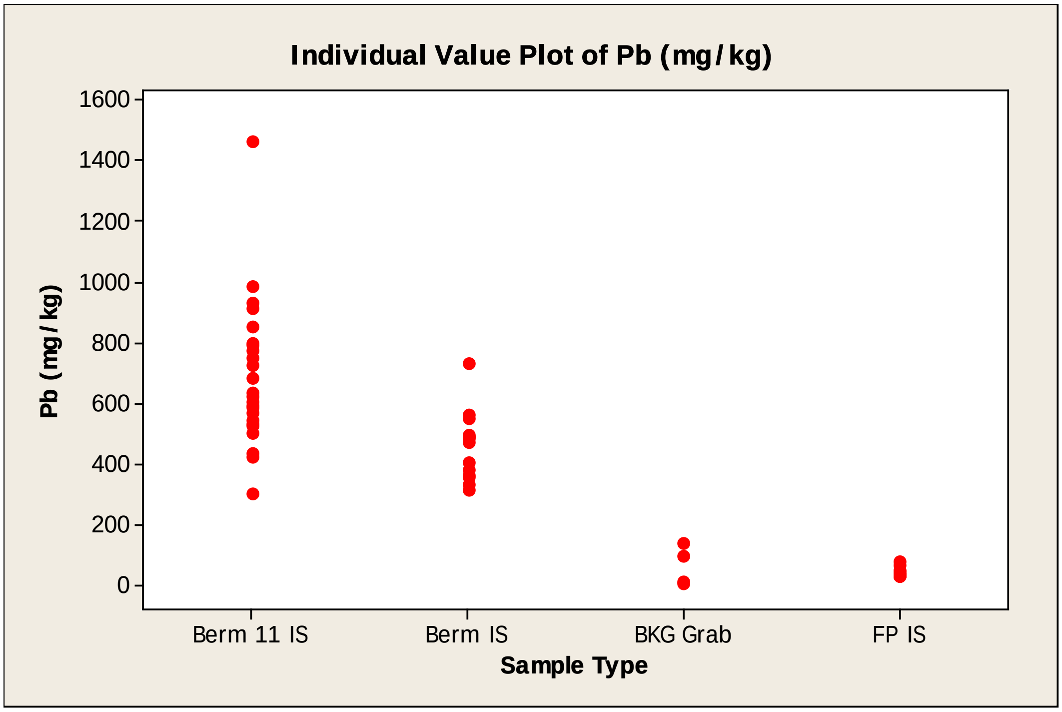
Appendix H-7

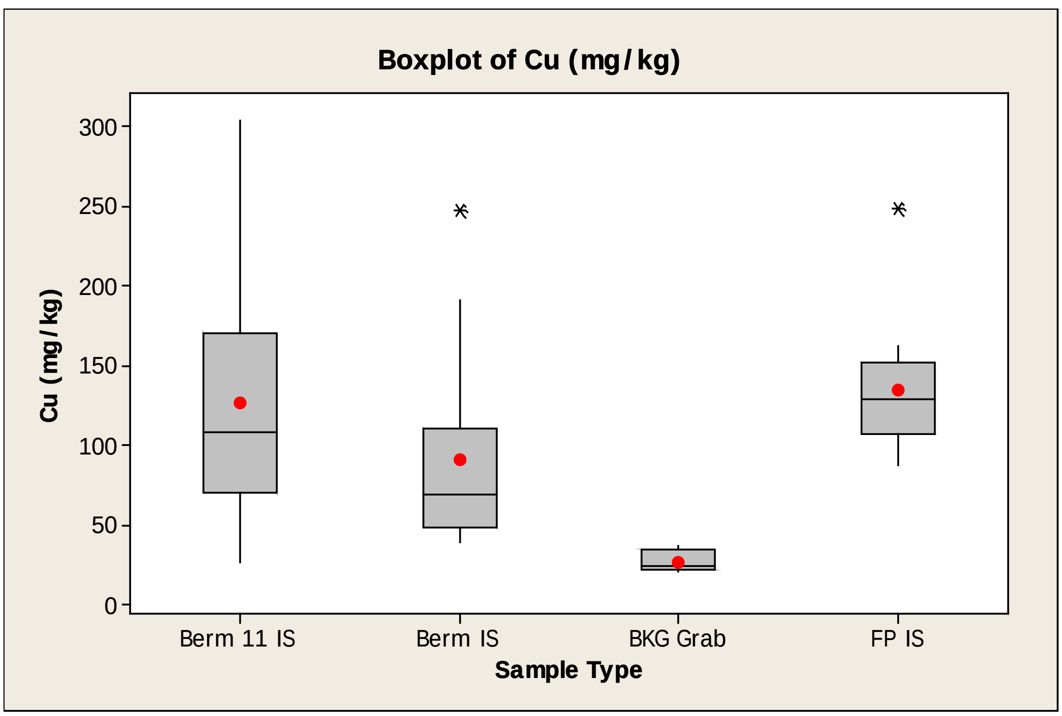
H-7.1. Descriptive statistics for grab background, IS berm and IS FP Pb, Cu, and Zn concentrations.

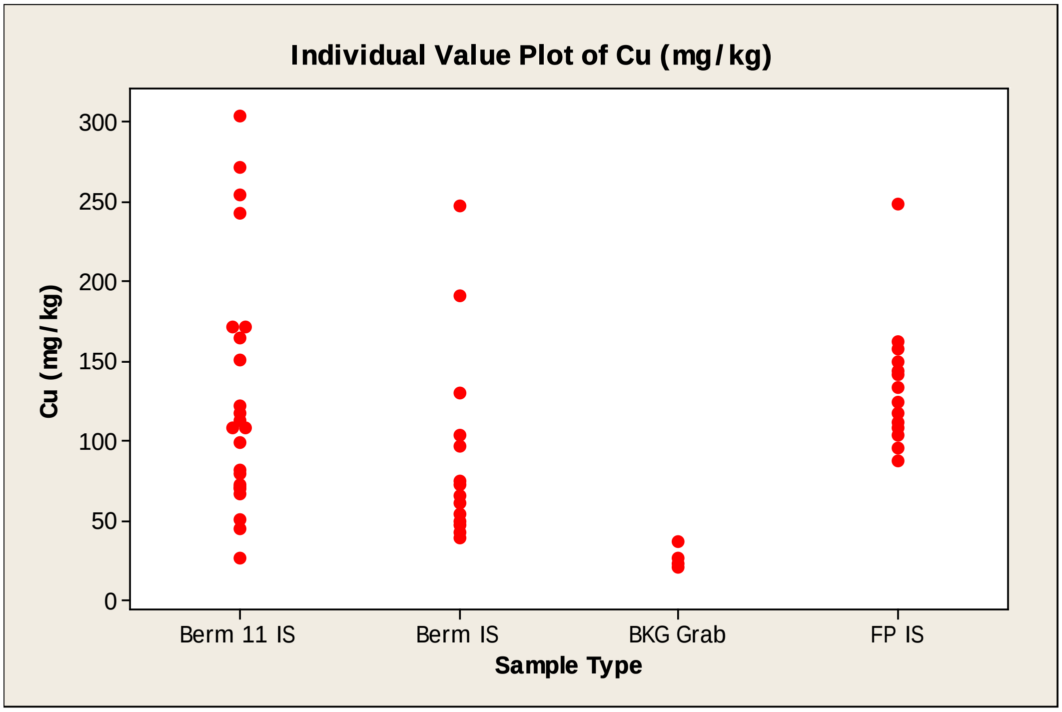
Variable	Sample Type	Total Count	N	Mean	StDev	Minimum	Median	Maximum
Pb (mg/kg)	Berm 11 IS	24	24	687.5	237.4	302.0	628.5	1460.0
	Berm IS	15	14	457.8	112.3	311.0	474.0	732.0
	BKG Grab	4	4	63.7	62.8	8.1	55.4	136.0
	FP IS	15	14	41.57	14.21	27.40	37.25	76.20
Cu (mg/kg)	Berm 11 IS	24	24	126.4	76.1	26.1	108.0	304.0
	Berm IS	15	14	91.1	60.9	39.5	69.3	247.0
	BKG Grab	4	4	26.75	7.10	21.20	24.45	36.90
	FP IS	15	14	134.7	40.0	88.0	129.0	248.0
Zn (mg/kg)	Berm 11 IS	24	24	58.93	10.52	27.20	57.50	79.00
	Berm IS	15	14	55.76	7.22	49.80	53.00	74.30
	BKG Grab	4	4	58.55	8.63	47.00	60.40	66.40
	FP IS	15	14	53.71	16.78	35.70	53.95	82.60

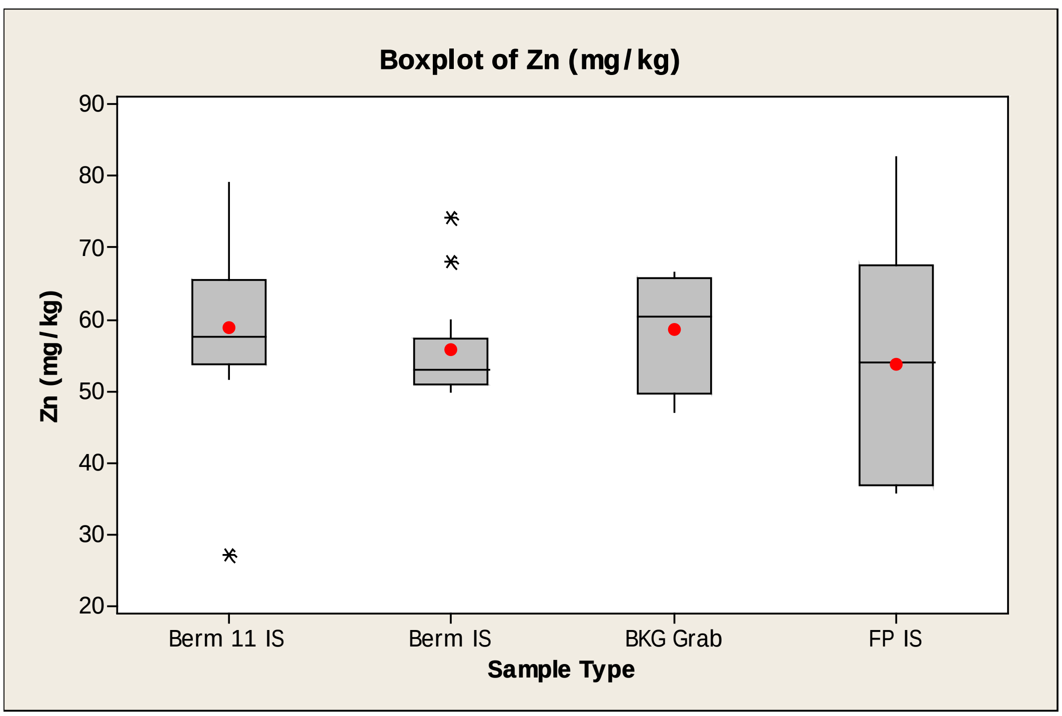
H-7.2. Boxplots for grab background, IS berm and IS FP Pb, Cu, and Zn concentrations.

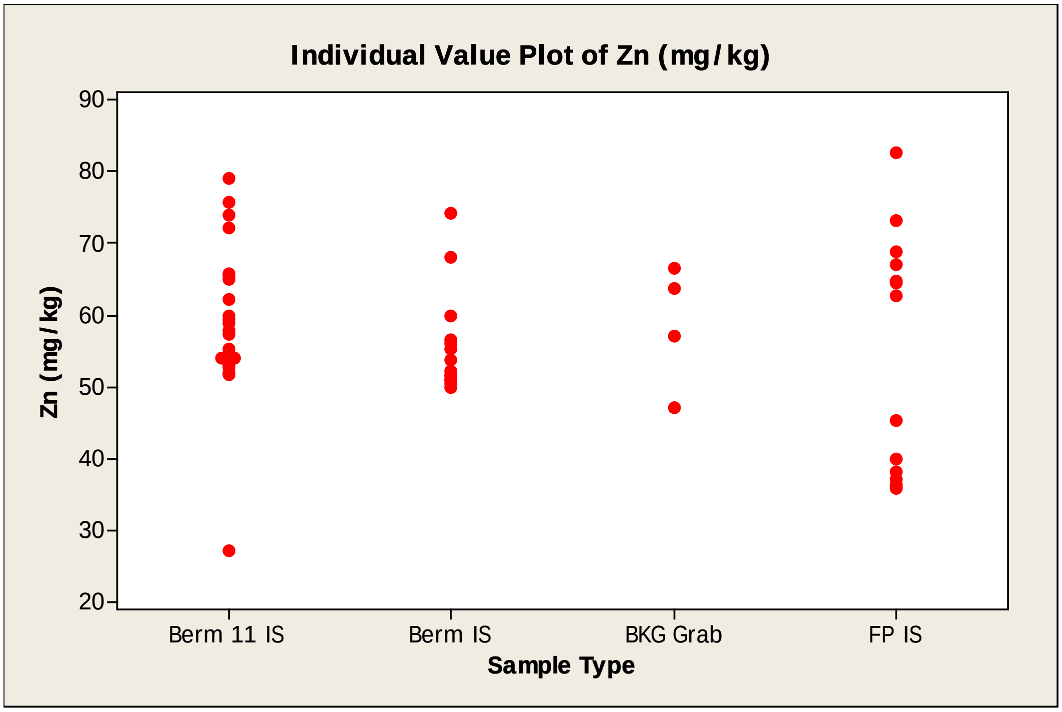


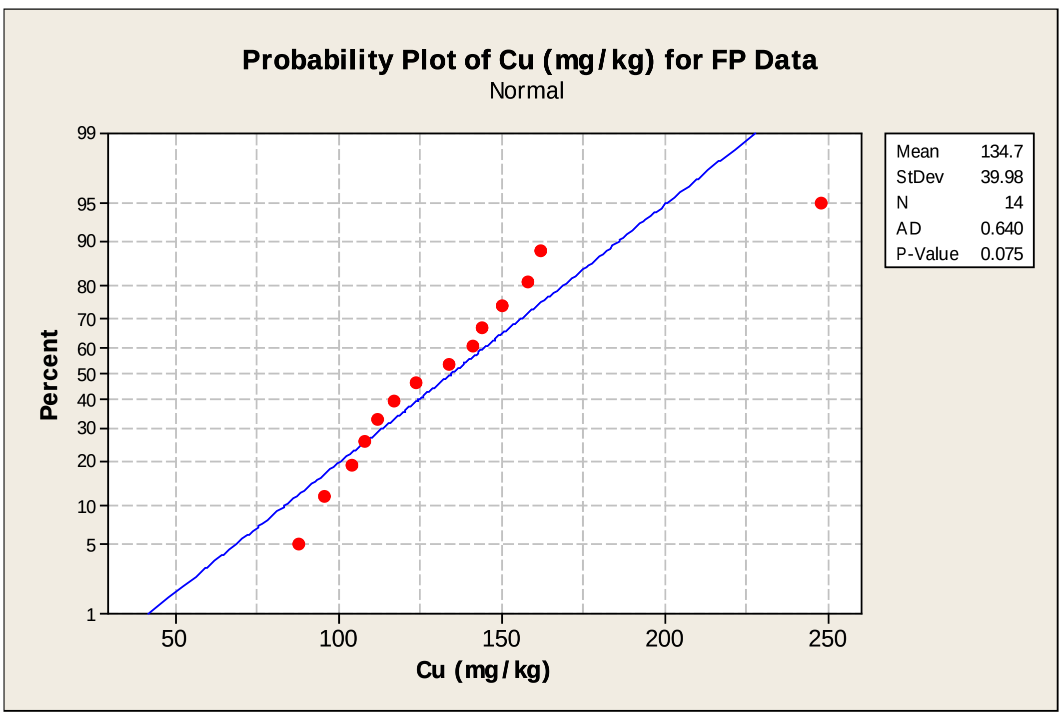

Individual Value Plot of Pb (mg/kg)
Pb (mg/kg)
1600
1400
1200
1000
800
600
400
200
0
Berm 11 IS
Berm IS
BKG Grab
FP IS
Sample Type


Boxplot of Cu (mg/kg)
Cu (mg/kg)
300
250
200
150
100
50
0
Berm 11 IS
Berm IS
BKG Grab
FP IS
Sample Type


Individual Value Plot of Cu (mg/kg)
Cu (mg/kg)
300
250
200
150
100
50
0
Berm 11 IS
Berm IS
BKG Grab
FP IS
Sample Type


Boxplot of Zn (mg/kg)
Zn (mg/kg)
90
80
70
60
50
40
30
20
Berm 11 IS
Berm IS
BKG Grab
FP IS
Sample Type


Individual Value Plot of Zn (mg/kg)
Zn (mg/kg)
90
80
70
60
50
40
30
20
Berm 11 IS
Berm IS
BKG Grab
FP IS
Sample Type

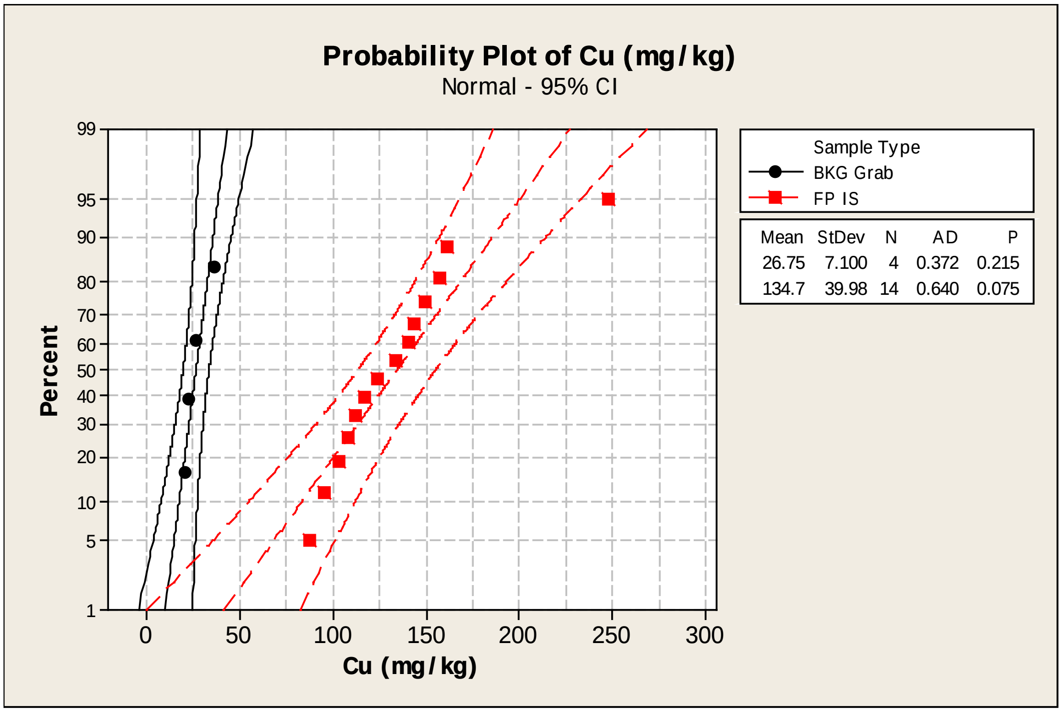

Probability Plot of Cu (mg/kg) for FP Data
Normal
Percent
99
95
90
80
70
60
50
40
30
20
10
5
1
50
100
150
200
250
Cu (mg/kg)
Mean 134.7
StDev 39.98
N 14
AD 0.640
P-Value 0.075

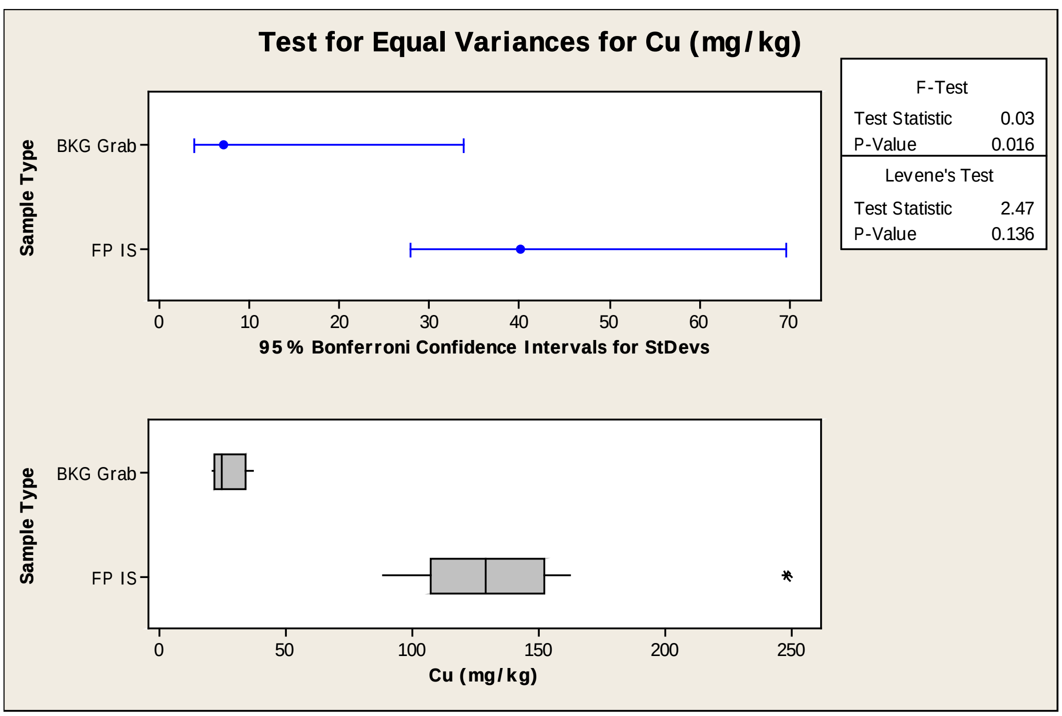
Appendix H-8: Summary of Pb, Cu, and Zn results

CRREL Lab ID	Sample Type	Cu (mg/kg)	Pb (mg/kg)	Zn (mg/kg)
B20-01	BKG Grab	36.90	8.08	66.40
B20-02	UL Grab	26.40	96.90	47.40
B20-03	UL Grab	29.20	89.80	50.70
B20-04	UL Grab	27.50	123.00	48.30
B20-05	UL Grab	23.50	21.40	47.90
B20-06	UL Grab	26.20	199.00	48.90
B20-07	UL Grab	23.90	69.70	47.10
B20-08	UL Grab	41.90	497.00	51.70
B20-09	UL Grab	30.00	264.00	50.70
B20-10	UL Grab	27.90	5.23	50.00
B20-11	UL Grab	457.00	3820.00	101.00
B20-12	UL Grab	23.60	50.90	47.80
B20-13	UL Grab	24.20	121.00	46.00
B20-14	UL Grab	28.10	156.00	46.40
B20-15	UL Grab	34.60	74.00	48.10
B20-16	UL Grab	48.80	565.00	50.90
B20-17	BKG Grab	22.60	136.00	63.70
B20-18	UR Grab	23.40	50.70	44.30
B20-19	UR Grab	20.20	24.10	44.90
B20-20	UR Grab	23.10	20.40	47.00
B20-21	UR Grab	25.00	61.40	48.30
B20-22	UR Grab	212.00	1670.00	70.40
B20-23	UR Grab	32.40	180.00	45.50
B20-24	UR Grab	24.80	78.60	46.30
B20-25	UR Grab	852.00	3570.00	140.00
B20-26	UR Grab	27.40	6.00	46.80
B20-27	UR Grab	825.00	4500.00	146.00
B20-28	UR Grab	24.20	38.50	46.30
B20-29	UR Grab	26.90	72.30	47.90
B20-30	UR Grab	22.90	49.10	35.60
B20-31	UR Grab	23.50	24.80	45.10
B20-32	BKG Grab	26.30	14.30	47.00
B20-33	UR Grab	26.70	11.60	47.10
B20-34	LC Grab	34.10	109.00	49.80
B20-35	LC Grab	41.00	41.10	50.90
B20-36	LC Grab	43.70	17.80	52.30
B20-37	LC Grab	27.00	114.00	49.00
B20-38	LC Grab	295.00	929.00	75.60
B20-39	LC Grab	30.30	145.00	50.10
B20-40	LC Grab	53.20	972.00	49.80
B20-41	LC Grab	35.90	432.00	51.00
B20-42	LC Grab	27.80	5.90	49.00

CRREL Lab ID	Sample Type	Cu (mg/kg)	Pb (mg/kg)	Zn (mg/kg)
B20-43	LC Grab	26.60	105.00	47.30
B20-44	LC Grab	34.30	288.00	45.90
B20-45	LC Grab	2.58	5.01	4.88
B20-46	LC Grab	30.80	81.50	45.10
B20-47	LC Grab	25.60	144.00	40.00
B20-48	LC Grab	43.40	748.00	37.70
B20-53	LC Grab	26.00	36.80	47.80
B20-54	UR Grab	25.90	30.50	48.30
B20-55	LC Grab	24.30	40.60	47.70
B21-02	Berm IS	74.40	489.00	56.00
B21-03	Berm 11 L IS	66.50	748.00	54.00
B21-04	Berm IS	191.00	480.00	68.00
B21-05	Berm IS	54.50	562.00	51.60
B21-06	Berm IS	42.60	379.00	50.40
B21-07	Berm 11 R IS	72.40	527.00	52.80
B21-08	FP IS	150.00	45.70	67.10
B21-09	FP IS	158.00	37.30	73.10
B21-10	Berm 11 R IS	79.70	528.00	53.50
B21-11	Berm 11 L IS	70.30	913.00	53.90
B21-12	Berm 11 L IS	44.70	590.00	52.90
B21-13	Berm 11 L IS	69.70	795.00	53.90
B21-14	FP IS	162.00	50.00	68.90
B21-15	FP IS	248.00	67.20	82.60
B21-16	Berm 11 L IS	165.00	1460.00	65.50
B21-17	Berm 11 R IS	50.40	604.00	51.70
B21-18	Berm IS	130.00	405.00	59.80
B21-19	Berm IS	39.50	311.00	50.80
B21-20	Berm 11 R IS	151.00	541.00	62.10
B21-21	Berm IS	72.90	356.00	53.80
B21-22	FP IS	141.00	37.90	62.70
B21-23	Berm IS	247.00	550.00	74.30
B21-25	Berm 11 L IS	108.00	636.00	57.30
B21-26	Berm IS	96.90	732.00	56.50
B21-27	Berm 11 L IS	243.00	682.00	74.00
B21-28	Berm 11 R IS	108.00	420.00	58.90
B21-29	FP IS	134.00	39.30	64.80
B21-30	Berm 11 R IS	81.50	586.00	54.80
B21-31	FP IS	144.00	76.20	64.40
B21-32	Berm IS	60.50	333.00	52.20
B21-33	Berm 11 R IS	254.00	722.00	72.10
B21-35	Berm 11 R IS	122.00	432.00	59.30
B21-36	Berm IS	104.00	495.00	55.20
B21-37	Berm 11 R IS	113.00	499.00	59.90

Appendix H-9: Evaluation of FP and background concentrations





Two-sample T-Test for Cu (mg/kg)

Sample Type	N	Mean	StDev	SE Mean
BKG Grab	4	26.75	7.10	3.6
FP IS	14	134.7	40.0	11

Difference = mu (BKG Grab) - mu (FP IS)
Estimate for difference: -107.9
95% CI for difference: (-131.9, -84.0)
T-Test of difference = 0 (verse not =): T-Value = -9.59 P-Value = 0.000 DF = 15

Appendix H-10: 95% UCLs from ProUCL for Pb, Cu, and Zn “Grab” and “IS” data sets

Metal	Grab*		IS*	
	95% UCL	UCL Type	95% UCL	UCL Type
Cu	190	Chebyshev	120	Approximate Gamma
Pb	1000	Chebyshev	510	Student’s t
Zn	58	Student’s t	59	Approximate Gamma

* Recommended 95% UCLs from ProUCL (Version 4.100) to two significant figures.

Appendix H-11: Squared rank tests for the variances

Squared ranks test for "Grab" and "IS" Pb results
Squared Ranks test for equal variances (for any continuous distribution)
Ho: var(gp1)=var(gp2) =...=var(gp k) versus Ha: not all vars equal
Test Statistic:18.699, p value : 0.000

Squared ranks test for "Grab" and "IS" Cu results
Squared Ranks test for equal variances (for any continuous distribution)
Ho: var(gp1)=var(gp2) =...=var(gp k) versus Ha: not all vars equal
Test Statistic:6.640, p value :0.010

Squared ranks test for "Grab" and "IS" Zn results
Squared Ranks test for equal variances (for any continuous distribution)
Ho: var(gp1)=var(gp2) =...=var(gp k) versus Ha: not all vars equal
Test Statistic:2.048, p value:0.152

Squared ranks test "Berm 11 L IS" and "Berm 11 R IS" Pb results
Squared Ranks test for equal variances (for any continuous distribution)
Ho: var(gp1)=var(gp2) =...=var(gp k) versus Ha: not all vars equal
Test Statistic:0.670, p value:0.413

Squared ranks test "Berm 11 L IS" and "Berm 11 R IS" Cu results
Squared Ranks test for equal variances (for any continuous distribution)
Ho: var(gp1)=var(gp2) =...=var(gp k) versus Ha: not all vars equal
Test Statistic:0.232, p value :0.630

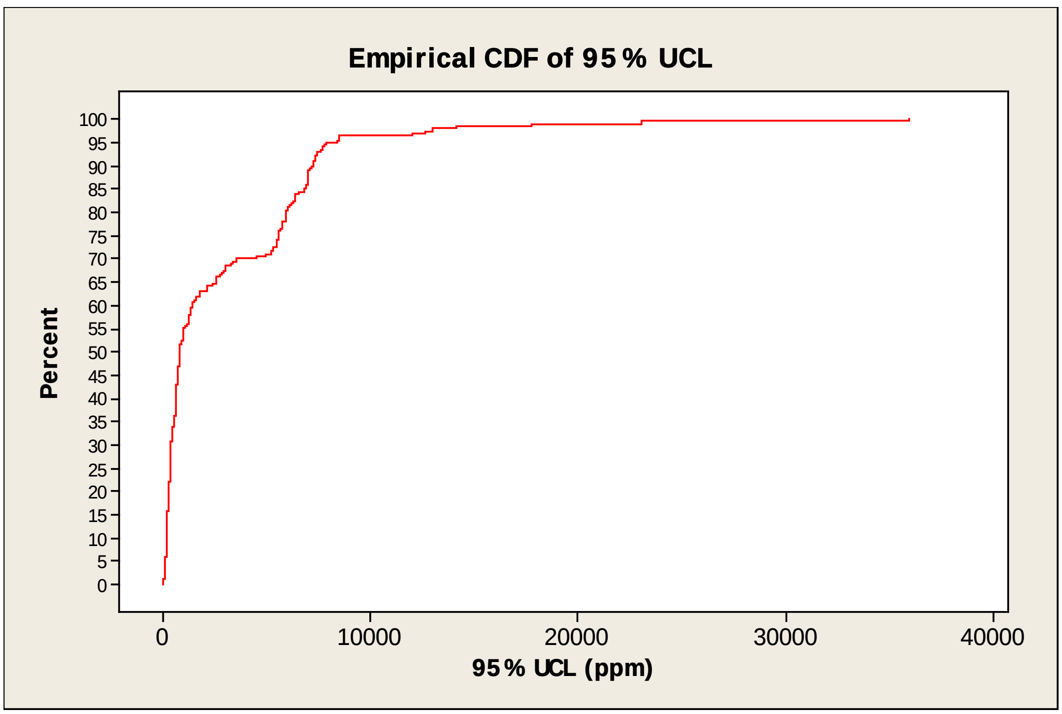
Squared ranks test for "Berm 11 L IS" and "Berm 11 R IS" Zn results
Squared Ranks test for equal variances (for any continuous distribution)
Ho: var(gp1)=var(gp2) =...=var(gp k) versus Ha: not all vars equal
Test Statistic:0.058, p value .809

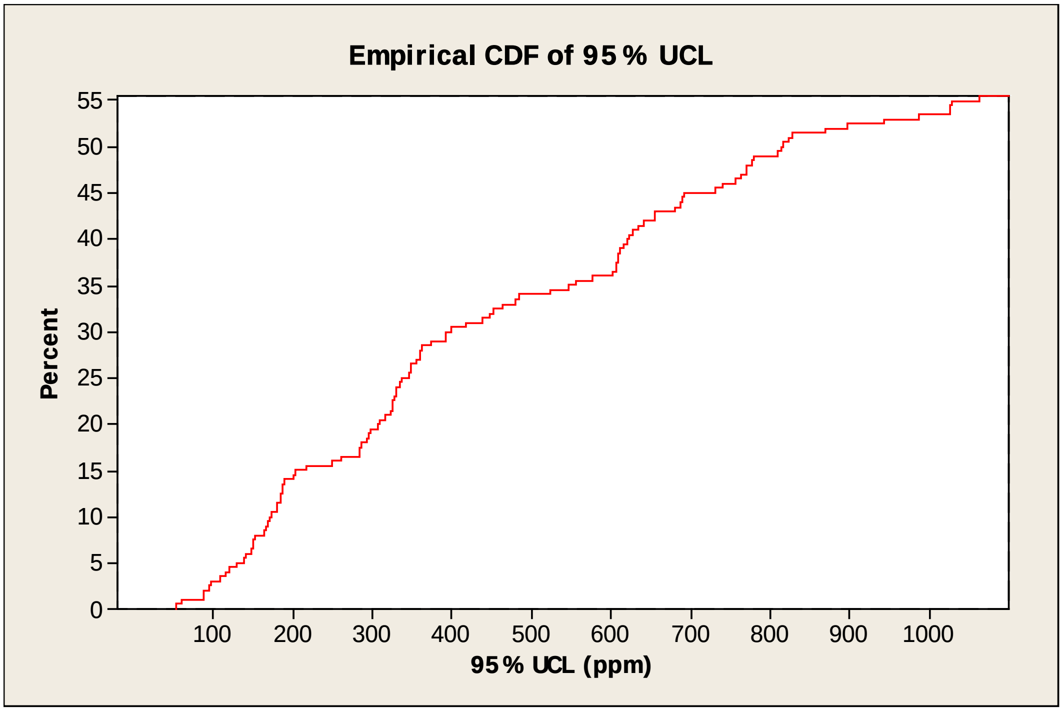
Appendix H-12: Fort Wainwright Lead (Pb) simulations

A set of $m = 7$ Pb results were randomly selected from the set of $n = 48$ Fort Wainwright grab samples using sampling without replacement. This was done 200 times. A 95% upper confidence limit (UCL) was subsequently calculated for each of the 200 sets of 7 grab samples using ProUCL (Version 4.1). Some descriptive statistics are presented below.

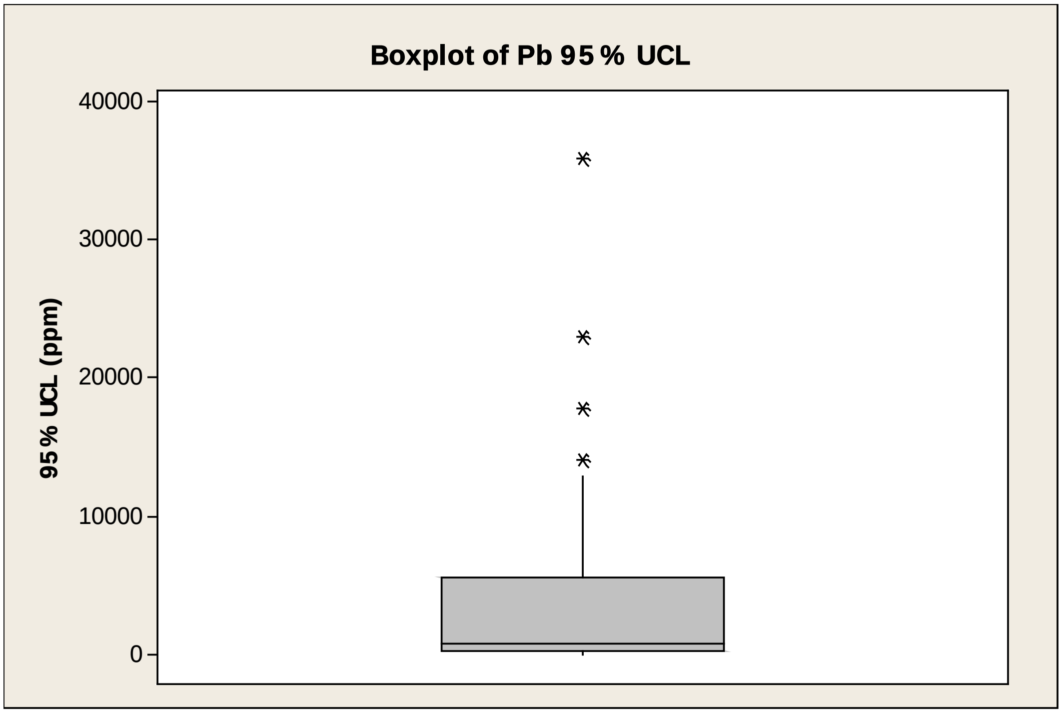
```
Descriptive Statistics: 95% UCL
Variable     N  Mean  StDev  Minimum  Median  Maximum   IQR
95% UCL    200  2915   4238       53     816    35991  5210
```

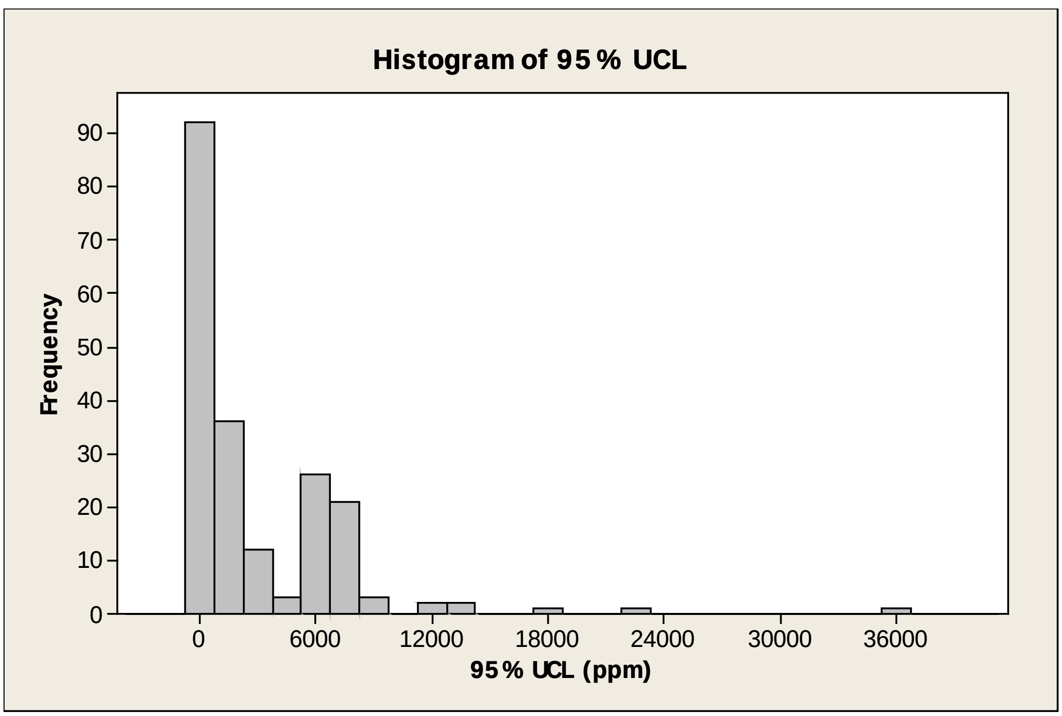
The median 95% UCL = 816 mg/kg. About 30% of the UCLs are less than 400 ppm (the typical decision limit for Pb). About 20% of the 95% UCLs are less than 300 ppm and 14% are less than 200 ppm. The cumulative distribution function (CDF) for the simulated UCLs is shown below.





The UCLs are very variable; the %RSD is about 145%. The 95% UCLs range from 53 to 35991, a span of nearly three orders of magnitude. The distribution of 95% UCLs is also very positively skewed and exhibits several large outliers (e.g., as shown below in the boxplot and histograms for the Pb 95% UCLs).





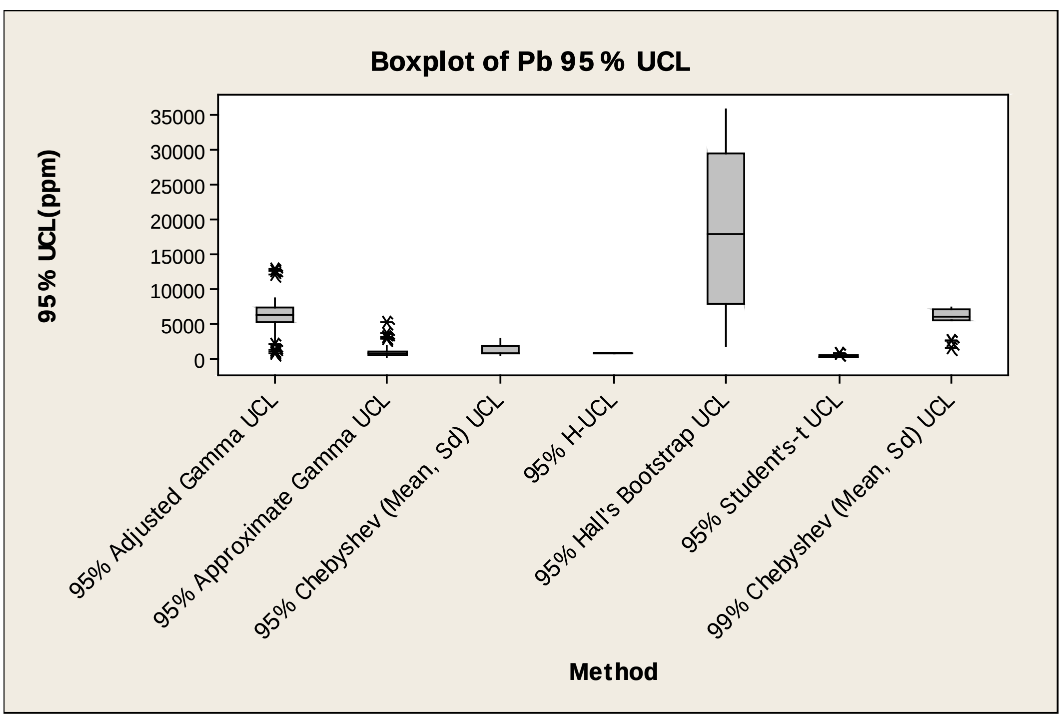
The UCLs most commonly selected by ProUCL were predominately the following: “95% Approximate Gamma UCL” (about 42%), “95% Adjusted

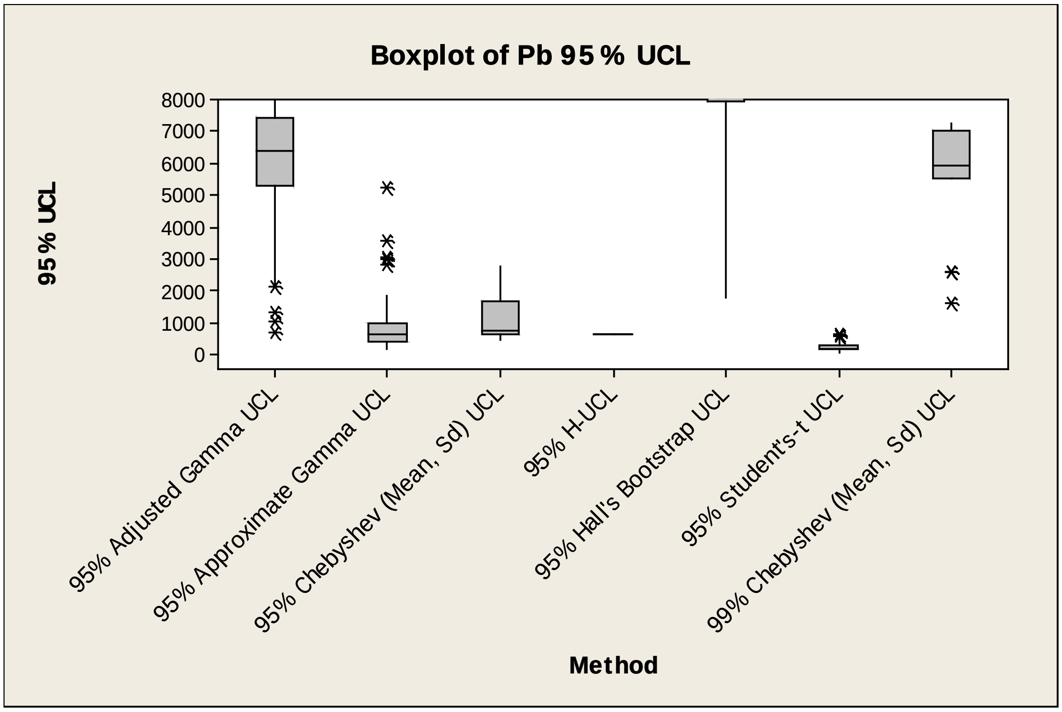
Gamma UCL" (about 24%), "95% Student's-t UCL" (about 18%), and "99% Chebyshev (Mean, Sd) UCL" (10%). Other types of UCLs were selected less than 6% of the time. Some descriptive statistics for the various types of UCLs calculated by ProUCL are presented below:

Descriptive Statistics: Pb 95% UCL Calculated by Different Methods

Variable	Method	N	Mean	StDev	Minimum	Median	Maximum
95% UCL	Use 95% Adjusted Gamma U	48	6169	2611	691	6356	12983
	Use 95% Approximate Gamma	83	836.5	811.9	152.0	620.5	5241.0
	Use 95% Chebyshev (Mean)	6	1116	856	448	747	2767
	Use 95% H-UCL	1	607.20	*	607.20	607.20	607.20
	Use 95% Hall's Bootstrap	5	18561	12512	1773	17805	35991
	Use 95% Student's-t UCL	37	220.8	147.4	52.9	170.4	641.7
	Use 99% Chebyshev (Mean)	20	5455	1718	1613	5928	7268

The various methods of calculation tended to produce very different results (e.g., as shown in the boxplots of the various types of UCLs reported by ProUCL). For the calculation methods commonly selected, the 95% Adjusted Gamma UCLs and 99% Chebyshev UCLs tended to be the largest UCLs; the median UCL for both of these methods was about 6000 ppm. The 95% Student's-t method produced the smallest UCLs; the median was about 200 ppm. The 95% Approximate Gamma UCLs tended to be several times larger than the Student's t UCLs; the median was about 600 ppm.





The variable UCLs suggest that when there is large heterogeneity (e.g., owing to metal fragments in soil), reliable (reproducible) estimates of means are unlikely when small numbers of grab samples are collected and analyzed. Although the actual population mean is unknown, the grab samples and incremental samples were used to calculate confidence limits for the population mean. The simulated UCLs were then compared with the confidence interval for the population mean to evaluate bias (i.e., in terms of the number of times the simulated UCLs fall outside the confidence interval, over or under estimating the population mean).

To calculate confident limits of the mean, a set of 48 results was randomly selected using sampling with replacement from the set of n = 48 Pb grab concentrations; and the mean was calculated. This was done 10,000 times to calculate a non-parametric bootstrap upper 95% confidence limit of the mean (the 95% percentile of the set of 10,000 means). A two-side 95% bootstrap confidence interval (CI) of 193–736 ppm was calculated. (The bootstrap 95% upper confidence limit of the mean is 679 mg/kg).

Using ProUCL, the data set "IS Entire Berm," the set of n = 15 incremental samples of 96 increments each gives a 95% UCL Student's-t = 498 mg/kg. The mean is 435.8 mg/kg. The two-sided Student's-t 95% CI for the population mean is 360 to 512 ppm. Note that this two-side CI falls within the two-side CI calculated for the grab samples using the bootstrap method described above.

On the basis of the CIs calculated from the grab samples and incremental samples, it is unlikely that the population mean is less than 200 or greater than 700 ppm. Therefore, to evaluate the simulated UCLs, it is assumed the population mean falls within this interval. The 95% UCLs from the simulation over estimate the mean 55% percent of the time (i.e., 55% of the 200 UCLs exceed 700 ppm). About 15% of the UCLs are at least one order of magnitude larger than 700 ppm. About 14% of the 95% UCLs from the simulation are less than 200 ppm, under estimating the population mean. Therefore, about 69% of the time, the sets of seven grab samples result in UCLs that were either biased high or low relative to the population; only 31% of the 95% UCLs from the simulation are between 200 and 700 ppm.

Table H-12.1. Grab Data Set for Entire Berm for Pb (n = 48), ppm.

Pb (mg/kg)	Pb (mg/kg)	Pb (mg/kg)
96.9	24.1	17.8
89.8	20.4	114
123	61.4	929
21.4	1670	145
199	180	972
69.7	78.6	432
497	3570	5.9
264	6	105
5.23	4500	288
3820	38.5	5.01
50.9	72.3	81.5
121	49.1	144
156	24.8	748
74	11.6	36.8
565	109	30.5
50.7	41.1	40.6

Table H-12.2. Incremental Sample (IS) Data Set for Entire Berm for Pb (n = 15), ppm.

Pb (mg/kg)
489
480
562
379
405
311
356
550
732
333
495
362
468
487
128

REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

1. REPORT DATE *(DD-MM-YYYY)*
September 2013

2. REPORT TYPE
Technical Report/Final

3. DATES COVERED *(From - To)*

4. TITLE AND SUBTITLE
Demonstration of Incremental Sampling Methodology for Soil Containing Metallic Residues

5a. CONTRACT NUMBER

5b. GRANT NUMBER

5c. PROGRAM ELEMENT NUMBER

6. AUTHOR(S)
Jay L. Clausen, Thomas Georgian, Anthony Bednar, Nancy Perron, Andrew Bray, Patricia Tuminello, Gordon Gooch, Nathan Mulherin, Arthur Gelvin, Marc Beede, Stephanie Saari, William Jones, and Shawna Tazik

5d. PROJECT NUMBER
ER-0918

5e. TASK NUMBER

5f. WORK UNIT NUMBER

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)

Cold Regions Research and Engineering Laboratory (CRREL)
US Army Engineer Research and Development Center
72 Lyme Road
Hanover, NH 03755-1290

8. PERFORMING ORGANIZATION REPORT NUMBER
ERDC TR-13-9

9. SPONSORING / MONITORING AGENCY NAME(S) AND ADDRESS(ES)
Environmental Security Technology Certification Program (ESTCP)
Arlington, VA 22203

10. SPONSOR/MONITOR'S ACRONYM(S)
ESTCP

11. SPONSOR/MONITOR'S REPORT NUMBER(S)

12. DISTRIBUTION / AVAILABILITY STATEMENT
Approved for public release; distribution is unlimited.

13. SUPPLEMENTARY NOTES

14. ABSTRACT

Objectives of this project were to demonstrate improved data quality for metal constituents in surface soils on military training ranges and to develop a methodology that would result in the same or lower cost. The demonstration was conducted at two inactive small-arms ranges at Fort Eustis, VA, and Kimama Training Site (TS), ID, and at one active small-arms range at Fort Wainwright, AK. The samples included 63 Incremental Sampling Methodology (ISM) and 50 conventional grab from Fort Wainwright, 18 ISM and 30 grab from Kimama TS, and 27 ISM and 33 grab from Fort Eustis. The variability in metal concentrations as measured with replicate samples and evaluated using percent relative standard deviation (RSD) were less than 10% for all metals using ISM. In contrasts, RSDs were often greater than 50% for conventional replicate grab samples. Calculated mean ISM metal concentrations were statistically greater than the mean for conventional grab samples.

15. SUBJECT TERMS

Antimony
Copper
Decision unit (DU)
Incremental sampling methodology (ISM)
Lead
Metals
Ranges
Surface soil

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT	**b. ABSTRACT**	**c. THIS PAGE**			**19b. TELEPHONE NUMBER** *(include area code)*
U	U	U	U	287	

Standard Form 298 (Rev. 8-98)
Prescribed by ANSI Std. 239.18